ACIDLOOP

DETAILED PROJECT BROCHURE




PROJECT FUNDED BY

PROJECT IMPLEMENTED BY

Imprint

Dr Malini Balakrishnan
The Energy and Resources Institute (TERI)
Darbari Seth Block, IHC Complex, Lodhi Road,
New Delhi - 110 003, India
Tel.: +91 11 2468 2100
+91 11 4150 4900
Fax: +91 11 2468 2144
+91 11 2468 2145
Mail: malinib@teri.res.in
Website: http://www.teriin.org

Authors:
Malini Balakrishnan (TERI), Vidya Batra (TERI), Rajat Batra (Stenum Asia), Markus Möller (AREC), Stefan Melnitzky (AREC), Pavel Ivashechkin (BFI), Miriam Sartor (BFI), Frederik Eisinger (adelphi), Rainer Agster (adelphi)

Editor:
Frederik Eisinger (adelphi)

Design:
Nicole Sillner, alma grafica UG

SWITCH-Asia

The overall objective of the SWITCH-Asia Programme is to promote sustainable growth, to contribute to the economic prosperity and poverty reduction in Asia and to mitigate climate change. For more information, see:
www.switch-asia.eu

Content

अशोक लवासा
ASHOK LAVASA, IAS

सचिव
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Secretary
Government of India
Ministry of Environment, Forest and Climate Change

सत्यमेव जयते

February 09, 2016

Foreword

2015 has been a decisive year for sustainable development and climate action. The Climate Change Division within Ministry of Environment, Forests and Climate Change (MoEF&CC) is India's nodal agency for climate change and as part of Intended Nationally Determined Contribution (INDC), the emissions intensity of GDP is intended to be reduced by 33 to 35 percent by 2030 from the 2005 level. As part of the Sustainable Development Goals (SDGs), countries have to implement the 10-year framework of programmes on Sustainable Consumption and Production (SCP). Furthermore, in the context of these international and domestic initiatives, new national initiatives like "Make in India", "Zero Effect, Zero Defect" and "Swachh Bharat" have also been announced. Fostering SCP in Indian SMEs is crucial in accomplishing the international and national goals in these aspects.

By promoting SCP in India's metal finishing sector, the ACIDLOOP project has made valuable contributions in moving India towards greater environmental sustainability. This project brochure which highlights the features of the project and the results is most welcome. I hope that the business case for SCP, which comes through convincingly from the examples in this brochure, will motivate others to take up such initiatives.

Lavasa

(Ashok Lavasa)

इंदिरा पर्यावरण भवन, जोर बाग रोड़, नई दिल्ली-110 003 फोन : (011) 24695262, 24695265, फैक्स : (011) 24695270
INDIRA PARYAVARAN BHAWAN, JOR BAGH ROAD, NEW DELHI-110 003 Ph. : (011) 24695262, 2465265, Fax : (011) 24695270
E-mail : secy-moef@nic.in, alavasa@nic.in, Website : moef.gov.in

Introduction

OVERVIEW OF STATUS INCLUDING KEY RESULTS AT THE END OF THE PROJECT

As you are reading this publication, the ACIDLOOP project has come to an end. Implemented between the beginning of 2012 and the beginning of 2016, the European Union (EU) funded project has supported **106 metal finishing companies** across India in becoming more resource efficient. During the project we have conducted **more than 50 workshops and trainings**. Due to the improvement potential identified by the project team and the implemented Resource Efficient and Cleaner Production (RECP) measures, the **energy consumption** across all companies could be reduced by **23%**. Overall **material consumption** could be reduced by **27%** and **water consumption** by **33%**. Building on this success and the experiences collected throughout the project period, the ACIDLOOP initiative, comprising the main partners of the ACIDLOOP project, will continue to offer RECP support to metal finishing companies in India.

OBJECTIVE OF THIS BROCHURE

With this brochure the results and success stories of the ACIDLOOP project are available to a wider audience. Whether you own a company yourself, work in a metal finishing company, source products from a metal finisher, are a consultant, a regulator or policy maker or are just interested in resource efficient and cleaner production in the metal finishing sector generally, this brochure will give you a broad overview on what the ACIDLOOP project has achieved. Besides giving you an idea on the past actions, this brochure will also lay out how the ACIDLOOP initiative will continue the work of the project in the future.

STRUCTURE OF THE BROCHURE

The brochure gives you an overview of the different activities implemented under the ACIDLOOP project. After giving you some background information on the project approach in **Chapter 2**, you will find more details on what we understand as Resource Efficiency and Cleaner Production (RECP) in **Chapter 3**. As training of companies and consultants was one of the key elements of the ACIDLOOP project and continues to be an important service offered by the ACIDLOOP initiative, the capacity building approach applied is presented in **Chapter 4**. **Chapter 5** goes into detail on the actual consultancy support that selected companies have received from the ACIDLOOP team. For a better understanding of what benefits the companies derived from this consultancy service, some exemplary interventions are presented. During the ACIDLOOP project, the consortium developed three pilot plants for acid regeneration and water recovery using -European technology. The results from this technology component of the project are described in **Chapter 6**. Throughout this brochure we will be stressing that developing a company's RECP strategy and striving for RECP implementation in a company cannot be achieved by only focusing on the particular company. In fact, it is required to sensitise and involve other stakeholders that the company is linked to, such as its customers, its banks, its technology suppliers or authorities in charge of environmental regulation affecting the company. How this was accomplished in the ACIDLOOP project and what the ACIDLOOP initiative offers for continuous engagement with such actors is outlined in **Chapter 7**. **Chapter 8** takes a look into the future. The ACIDLOOP project has ended but the ACIDLOOP initiative has gained broad experiences in the work with metal finishing MSMEs across India that are available for further interventions in this sector. In this final part we present our ideas for making the Indian metal finishing sector even more resource efficient in the future and the services offered by the ACIDLOOP initiative.

THE ACIDLOOP INITIATIVE

Throughout this brochure we will be talking about the ACIDLOOP project and the ACIDLOOP initiative. The ACIDLOOP project was the project funded by the SWITCH-Asia programme from 02/2012 to 01/2016. The ACIDLOOP initiative is the consultancy approach offered by the Indian partners TERI and Stenum Asia with support from the international partners AREC and adelphi. Services offered by the ACIDLOOP initiative include direct company consultancy as well as trainings, workshops, reports, study tours and more for all institutions and organisations interested in fostering RECP in the metal finishing sector.

The Project Approach and Background

THE SWITCH ASIA PROGRAMME

The ACIDLOOP project (2012 – 2016) was part of the European Union's SWITCH-Asia programme. The SWITCH-Asia programme was launched by the European Commission in 2008. Its goal is to promote economic prosperity and to help reduce poverty by encouraging a sustainable growth with low environmental impact from industries and consumers. The programme specifically aims to promote sustainable products, processes, services and consumption patterns in Asia. ACIDLOOP was one of more than 80 grant projects being implemented under the SWTICH-Asia programme in 16 Asian countries.

More information on the SWITCH-Asia programme can be accessed on the SWITCH-Asia website:
http://www.switch-asia.eu/

switchasia PROGRAMME

"For the past four years, the ACIDLOOP project has worked with more than 100 companies across India. We are proud to say that this cooperation has resulted in energy savings of almost 23% and material savings of more than 21% across all companies."
Stefan Melnitzky
AREC, International RECP Expert and ACIDLOOP project partner

PROJECT PARTNERS

The ACIDLOOP project was implemented by a project consortium comprising organisations from India, Germany, Austria and Philippines – each with a specific expertise contributing to the overall success of the project. The project was led and coordinated by The Energy and Resources Institute (TERI) from India. The other Asian project partners were STENUM Asia and the Society of Indian Automobile Manufacturers (SIAM), both from India and the Asia Society for Social Improvement and Sustainable Transformation (ASSIST) from Philippines. The European project partners were the German VDEh-Betriebsforschungsinstitut GmbH (BFI) and adelphi research and Austria Recycling (AREC).

TERI is a not-for-profit research organization working on all dimensions of sustainable development targeted at finding solutions to global problems in the fields of energy, environment and current patterns of development.
TERI was responsible for overall project coordination and the project activities in the West, i.e. Pune, Aurangabad, Ahmedabad and Vadodara.

adelphi is a leading independent think tank and public policy consultancy on climate, environment and development.
adelphi was responsible for the implementation of policy dialogues and activities related to RECP-financing.

Asia Society for Social Improvement and Sustainable Transformation (ASSIST) is a non-stock non-profit organization whose primary focus is to increase environmental protection among the public and the business sector as well as to increase business cooperation and networking. ASSIST was responsible for the project activities in the South, i.e. Chennai.

Austria Recycling Verein zur Förderung von Recycling und Umweltschutz in Österreich (AREC) has worked actively with galvanizing companies involving zero emission retrofitting projects and has more than 15 years of experience in SME consulting in Europe and many parts of Asia. AREC was responsible for the development and implementation of trainings on RECP as well as individual company consultations on RECP potentials and evaluation of final results.

VDEh-Betriebsforschungsinstitut GmbH (BFI) is a leading European provider of application-focused R&D in the field of steelmaking technology.
BFI was responsible for the development, installation and maintenance of the three acid regeneration and water recovery plants as well as the linkages to technology suppliers.

STENUM Asia Sustainable Development Society is a training and consultancy organisation, registered in Gurgaon, India since 2007. It has extensive experience in promoting sustainable development at enterprises (in India, Nepal and Bhutan) through the Resource Efficiency approach. STENUM Asia was overall responsible for the on-site consulting at MSMEs across project locations and for project activities in the North, i.e. Faridabad, Gurgaon and Chandigarh-Mohali.

Society of Indian Automobile Manufacturers (SIAM) is an industry body representing 38 leading vehicle and vehicular engine manufacturers in India and works closely with all the concerned stakeholders to actively formulate rules, regulations and policies related to the automotive industry. SIAM was responsible for establishing linkages to customers from the automotive sector of the metal finishing companies

THE INDIAN METAL FINISHING INDUSTRY

You might ask why the ACIDLOOP project targeted the Indian metal finishing industry in the first place. In fact, the Indian metal finishing sector is primarily comprised of micro, small and medium enterprises (MSMEs). Many of them have low technical and financial capacities. At the same time, the metal finishing sector handles a variety of hazardous substances and consumes large amounts of water and energy. The combination of these two issues – the low capacities of MSMEs and the high RECP potential of the metal finishing sector – make this sector a natural candidate for RECP interventions.

On a macro-economic level, increased economic activities and continuous population growth force India to embark on a path of more resource efficient production. The exploitation of natural resources and their inefficient use as well as the resulting negative environmental effects pose a serious threat to India's further economic growth. RECP measures leading to reduced resource consumption can thus ensure the business continuity of many enterprises and enhance the competitiveness of the Indian economy.

MSMEs play an important role in India's manufacturing industry, both in terms of output and exports as well as employment figures. It is estimated that MSMEs account for 45% of India's manufacturing output and for about 40% of the country's total exports (Government of India 2010). Moreover, a total of 45 million MSMEs employ about 100 million persons. The success story of India's economic growth and its MSME sector is contrasted by increasing environmental degradation and adverse effects of economic activities on the ecological systems, particularly from MSMEs.

According to studies, MSMEs account for 70% of all industrial pollution in India (Rawat et al. 2012). Due to a series of challenges faced by MSMEs in particular, support in identifying RECP improvement potentials and assisting MSMEs in implementing them is required (Chandra 2008):

- First of all, there is a **problem of awareness** on the side of MSMEs on RECP improvement potentials in their plants.
- In their daily business operations, MSMEs have **little to no time** for conducting RECP assessments and implementing new RECP measures and practices.
- Another important barrier preventing MSMEs to implement RECP measures are **financing constraints**. Implementing mid- and high-cost RECP measures usually requires high up-front investments, yet most MSMEs lack own financial resources and have more difficulties in obtaining loans from banks than larger companies.
- Apart from constraints regarding financial capacity, most MSMEs also face a **lack of skill and knowledge** required for the implementation of certain RECP practices and measures, i.e. professional staff to identify, implement and eventually operate RECP technologies.
- Finally, most MSMEs **lack communication channels or even a business network** to easily obtain information on the availability and benefits of RECP measures.

The correlation between economic activity and negative environmental impacts is particularly strong for MSMEs in the metal finishing sector. This is because processes of metal finishing require the usage of acids and other chemicals which have the potential of causing severe environmental damage if released into the environment or treated improperly.

WHAT IS METAL FINISHING?

Metal finishing is the process of surface modification with the aim of improving appearance and durability of the product. Metal finishing includes electroplating which is the application of dissolved metal ions through electric current as a coating to the surface of an object (EPA 2012). Other metal finishing processes are powder coating, galvanizing etc.

Mostly, metal finishing provides corrosion protection, erosion resistance and anti-frictional characteristics. However, metal finishing can also serve decorative purposes (EPA 2014).

In the process of the coating application, the metal finishing sector also performs tasks such as surface cleaning, surface treatment, rinsing and drying of metal parts. These operations include chemical and electrochemical conversions, diffusion coating techniques as well as case-hardening techniques (Sundaravadivel et al. 2006).

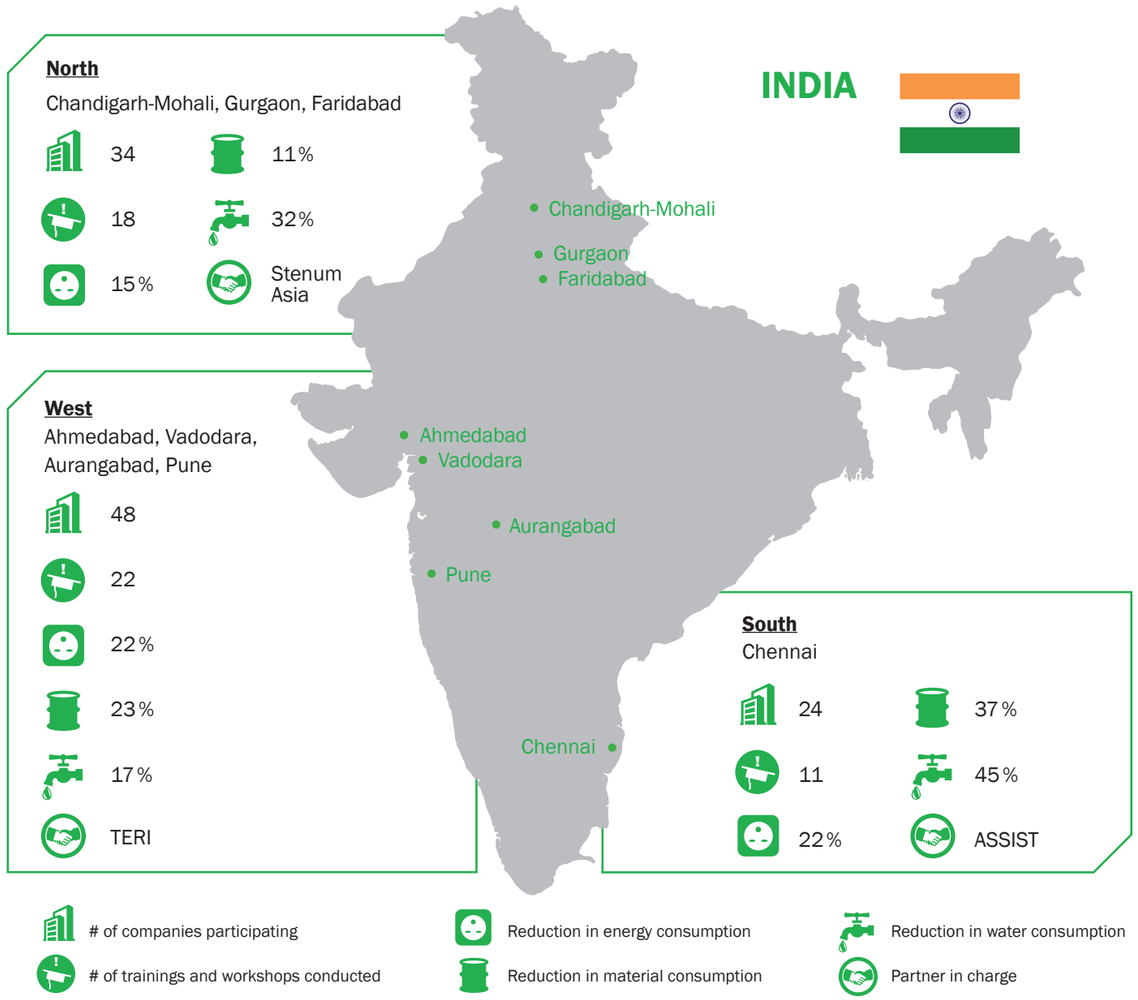
The ACIDLOOP project addressed resource consumption across all steps of the metal finishing process from the cleaning of the parts to be coated to the final packaging and dispatching.

Low environmental operation standards in the sector often go along with low health and safety standards, thus threatening the health of workers as well as the surrounding communities.

For these reasons the metal finishing sector was chosen as the target sector of the ACIDLOOP project. Besides working directly with metal finishing companies, the project also engaged with the wider stakeholder framework in which the MSMEs operate. This approach is based on the conviction that it cannot only be the MSMEs themselves that can manage the transition to RECP practices but that they require support from other actors, most notably their environmental authorities and policy makers, technology suppliers, customers, and financial institutions. Each of these groups was targeted with a specific set of activities under the ACIDLOOP project.

PROJECT FACTS

The project was implemented in eight different locations, spread across five different states clustered in three regions. The map below shows where the project regions were located and the key results in each region:



THE PROJECT APPROACH

The ACIDLOOP project comprised a number of work packages targeting metal finishing MSMEs, consultants as well as the other stakeholders mentioned above. The project work packages can be divided into three sets of activities that are displayed in the figure below.

The first set of activities is the direct support provided to companies through capacity building measures, direct consultation and hand-holding in the implementation of RECP measures. The second set of activities includes support activities that were required to realise the direct company support activities. These support activities are the training of national consultants who were to work on-site with the companies, the development of training materials and the technical support activities concerning the planning and development of the three demo-units.

The third set of activities includes stakeholder engagement activities that put the RECP approach in relation to policy-makers and authorities, financial institutions, customers, and technology suppliers.

Direct company support

Introductory Workshops

A series of introductory workshops held in several Indian cities informed metal finishing MSMEs on the project approach and invited them to join the project.

On-site consultation on RECP

All MSMEs participating in the project were visited by national and international RECP experts from the project team on a regular basis. After an RECP assessment at the beginning of the project, the MSMEs were supported in the implementation of actual RECP measures. In monitoring visits, the outcome (savings) were evaluated.

Major and minor workshops

A series of major workshops on different RECP-related topics was conducted for the participating metal finishing MSMEs. Minor workshops were conducted for exposure to demonstration systems.

Project support activities

Training of local RECP consultants

Project team members from TERI, STENUM Asia and ASSIST were trained in India, Germany, Austria on the ACIDLOOP-RECP approach as well as on basics of regeneration of waste acids and recovery of rinsing water from metal finishing processes. Interactive class room trainings were combined with training on the job during on-site visits.

Toolkit and training material development

The project team developed a webpage, a toolkit and training material on RECP in the metal finishing sector.

Mobile demonstration plants

Three mobile demonstration systems were developed for (a) nanofiltration, (b) diffusion dialysis, and (c) retardation. The plants were tested in selected MSMEs across India.

Stakeholder engagement

Policy dialogues

Environmental authorities and other stakeholders joined policy dialogues to discuss a more proactive role of these authorities to RECP and a promotion of this approach among MSMEs. The dialogues also covered the question how to create conditions so a better transfer of RECP technologies from research institutions to the industry can be accomplished.

Marketing events for financial institutions

Discussion rounds with financing institutions sensitised them on needs regarding MSMEs' access to financing for RECP measures. At the same time, MSMEs were informed about what banks require in order to sanction loans for RECP investments. To enable better direct access of MSMEs to banks, one-on-one visits to bank branches were conducted to inform loan officers on RECP investment opportunities.

Customer roundtables

In customer roundtables, the customers of metal finishing MSMEs came together. They were informed on potential RECP measures to be implemented and discussed ways of disseminating these practices among more of their suppliers.

Technology supplier roundtables and fairs

Technology suppliers came together in roundtables to discuss suitable technology options fostering RECP among metal finishing companies as well as barriers hampering the diffusion of such technologies and ways to overcome them.

INTERVIEW WITH DR. MALINI BALAKRISHNAN FROM TERI

ACIDLOOP Project Leader from TERI

Q: The ACIDLOOP project has now come to an end after four years – what does the project leave behind?

MB: We are leaving behind a wealth of experiences, knowledge, capacities, memories and – not to forget – friendships. On the technical side, the companies that we worked with could significantly reduce their resource consumption. These improvements will stay and the ideas on how to achieve them will spread through the industry associations that we worked with. We are leaving behind examples and good- as well as best-practices – seeds from which the idea of resource efficient and cleaner production may spread.

Dr. Malini Balakrishnan

Q: What have been difficulties during the project period that you had to overcome?

MB: In the beginning it was not always easy to convince the companies to go ahead with the suggestions that we were giving them on how to save resources in their operations. A lot of trust-building was required before the companies actually started believing in the ideas that we were advocating. As soon as the first results were felt, which meant that their costs for production inputs dropped, everyone was on board. It was great to see how the continuous hand-holding in combination with the positive results that we achieved finally convinced everyone about the benefits that we had to offer.

Q: Would you have done anything differently if you had the chance to start the project all over again?

MB: I think that with the results that we achieved not much of the approach would have to be changed. As I mentioned before it was not easy in the beginning to convince the companies to take up the interventions that we suggested. An idea could be to first develop and implement measures with few selected frontrunner companies. With these examples and practices it might have been easier to bring all the other companies on board. The project consortium has been looking at exporting this successful project to other countries in the region. If we get the chance to do this we would definitely consider this approach.

Q: How have you ensured that the project experiences will be of benefit to the industry after the end of the project?

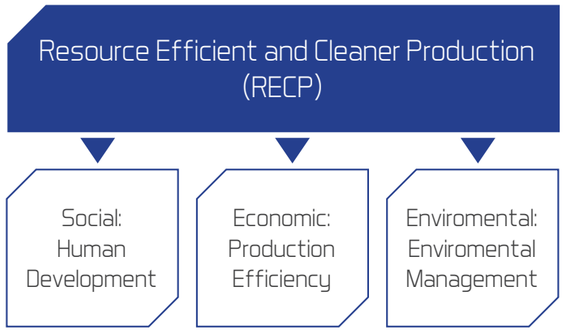
MB: Project sustainability has been an issue that was very important from the beginning of the project. We have made sure that all the project experiences, lessons learnt, and best practices have been transferred in documents and formats available to interested actors. In fact, even this project brochure is a source of information for companies and institutions. We have also always involved multipliers in our activities such as the local metal finishing associations to allow them to replicate the interventions that we have implemented with the participating companies. In addition, several of the project partners have formed the ACIDLOOP initiative which will continue to offer consultancy services on resource efficient and cleaner production in the metal finishing sector even after the end of the project.

Resource Efficient and Cleaner Production

Resource Efficient and Cleaner Production (RECP) is an approach for companies to increase their productivity and contribute to social, environmental and economic sustainability. The RECP approach combines two concepts:

- **Resource Efficiency** means "reducing the total environmental impact of the production and consumption of goods and services, from raw material extraction to final use and disposal" (UNEP, n.d.).
- **Cleaner Production** is a "continuous application of an integrated environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment" (UNEP n.d.). A company will notice the benefits of cleaner production in two ways: through minimised inputs and maximised outputs.

By combining these two concepts, the **Resource Efficient and Cleaner Production (RECP)** approach allows a company to improve both its economic performance and the sustainability of its production and consumption processes. In fact, RECP addresses all three dimensions of sustainability: from an economic perspective, it increases production efficiency; from an environmental perspective it minimises negative impacts on the environment; and from a social perspective, it promotes human development.



To make RECP successful it needs to be integrated in the structures of the company. RECP is not a mere question of implementing new technologies, but rather requires a common understanding of the complexities related to cleaner production and resource efficiency among all members of a company. Success of RECP approaches therefore very much depends on how well a RECP mind-set is integrated in all company structures.

It is crucial to make the responsible personnel in the company understand the potential that RECP measures have for a company in terms of process improvement, resource savings, environmental impact reduction, increase in productivity, general improvement of economic situation, and competitiveness.

One approach that comprises these elements is the ECOPROFIT© model which was applied in the ACIDLOOP project.

THE ACIDLOOP APPROACH

The ECOPROFIT© model was developed in Graz, Austria, in 1991. It has since been successfully implemented nationally and internationally.

The ECOPROFIT© approach consists of 3 elements:

- Joint workshops with participating companies
- Individual company consulting by trained experts
- Awards

To eventually receive the award, the companies have to fulfil specified RECP criteria such as certain reductions in energy or water consumption. The award honours companies' efforts to improve their production processes and to highlight the successes they achieved by implementing RECP measures.

As a change of company personnel's mind set towards RECP is not necessarily achieved in a short period of time, this approach is not a one-time intervention but should be continued over a certain period of time. Usually, all companies that have passed the first project stage participate in a replicator workshop where they are trained in advanced RECP practices and experiences are shared between the participating companies on day-to-day RECP measures implementation.

For the ACIDLOOP project, the approach has been adapted and tailored to the specific needs and conditions of the main target group – MSMEs from Indian metal finishing industries.

Capacity Building

The main goal of the RECP training programme for a company is to equip one or two employees from a company with the skills required for assessing RECP improvement potentials and implement RECP measures. The training approach combines presentations, interactive exercises, on-site assistance and consultation, as well as calculation of economic and environmental savings. At the end of the programme it is ensured that participating companies not only utilise their resources (raw materials, energy, water, hazardous material, etc.) optimally, but are also able to minimise overall waste generation. The three pillars of the **ACIDLOOP RECP** approach are:

- Technical presentations in workshops on specific topics such as material flow analysis, water, energy, waste, hazardous material, management skills, etc.
- On-site consultation and follow-up by international and national experts on specific topics to identify, evaluate, implement and monitor the options.
- Certificates given to participating companies in recognition of efforts after the quantification of achieved RECP benefits.

RECP is not focusing on specific areas or topics. It approaches a company as a whole and analyses its processes, procedures and technologies with respect to options for improvement. In a first step, the focus is on options improving the company's resource use with its actual equipment and facilities considering the economic situation of the company. These low and no cost options should be implemented first and are to be preferred compared to mid- and high-cost options. Low and no cost options have a short "return on investment". After having realised all low and no cost options, the savings can be utilised to invest in further and more costly RECP options, for example energy efficient equipment and new technologies.

RECP does not have a specific emphasis on the implementation of new technologies. The focus of RECP rather is to improve existing technologies in the companies and to develop appropriate measures to increase resource efficiency without investing a lot of money.

"ACIDLOOP is a boon for MSMEs because it exposes them to world class manufacturing as well as resource efficient and cleaner production (RECP) practices which is otherwise not available to MSMEs in the sector. ACIDLOOP plays a vital role in promoting RECP which directly helps the MSMEs to be competitive and helps the world and environment indirectly."
Mr K S Anbuselvan
The Institute of Indian Foundrymen (IIF) Chennai

Capacity building on RECP measures in the metal finishing sector was a key project activity under the ACIDLOOP project and it remains a key service offered by the ACIDLOOP initiative. The ACIDLOOP training approach for metal finishing MSMEs is based on a series of workshops covering the different stages in an RECP assessment process and the different needs of the companies. Four different types of capacity building measures were implemented under the project:

- Training course and training on the job for national consultants on RECP and basics of regeneration of waste acids and recovery of rinsing water from metal finishing processes.
- Introductory workshops for informing metal finishing MSMEs on the project details and the concept of RECP.
- Major workshops on RECP concepts, assessments, practical exercises and actual implementation of RECP measures.
- Minor workshops on demonstration systems for waste acids and rinse water recovery.

Practical training at BFI in Düsseldorf, Germany

RECP TRAINING FOR LOCAL CONSULTANTS

The ACIDLOOP project approach aimed at creating the necessary capacity for RECP assessment services in the metal finishing sector among its Indian team members. With AREC and BFI, the project consortium had two partners who are both highly knowledgeable on RECP in general (AREC) and metal finishing processes as well as the regeneration of acids and the recovery of rinsing water (BFI). To share this knowledge with the Indian team members who would be working on a day-to-day basis with the participating metal finishing companies, the ACIDLOOP project trained nine experts from TERI, ASSIST and STENUM Asia at AREC and BFI in Austria and Germany from 8 - 27 October 2012.

During their two-week stay in Graz and Vienna, Austria, participants received training on RECP by AREC on technical topics such as material flow analysis and energy management as well as on soft skills such as techniques for the effective organisation of meetings and training sessions. Learning was facilitated through presentations, interactive workshops, case studies, group discussions and company visits.

At BFI in Düsseldorf, Germany, the nine participants gained additional technical knowledge on closed loop technologies for regeneration and recovery of waste acids and rinsing water, including ion exchange, reverse osmosis, diffusion dialysis, micro-, ultra- and nano-filtration, and related approaches relevant for water and acid management. Additional lessons were taught on occupational health and safety. Apart from technical talks, the trainings also comprised interactive sessions and lab experiments.

Additional "Training on the job" is the key empowerment for the national consultants. Here they learned from experienced consultants during on-site visits techniques on handling the companies, in getting right and important information, on identifying RECP options and problem solving in actual situation through appropriate strategies and measures.

In order to refresh the content of trainings provided in Austria and Germany, the local consultants were regularly invited to meet in India for follow-up training courses. Refresher courses and team workshops took place in November and December 2013, November 2014, February 2015, May 2015 and July 2015. During these sessions the local consultants could informally discuss their experiences with facilitating the implementation of RECP measures and barriers for implementing RECP options in the participating companies. Other meetings focussed on dealing with the management personnel of participating companies and the options for progress monitoring reporting or further streamlining of on-site consultancies between the different project locations.

INTERVIEW WITH PRAHLAD TEWARI FROM TERI

A national consultant working with metal finishing companies from Pune, Aurangabad, Ahmedabad and Vadodara

Q: How did you benefit from the RECP training in Germany and Austria?

PT: Our month-long trip to Austria and Germany was a great experience and helped me and my colleagues a lot in building the capacities that we required for working with the metal finishing companies. In Austria, we learned a lot about RECP generally as well as on soft skills that we as consultants need to have for engaging with clients. In Germany, the focus was on the technical details of the metal finishing process. Learning the importance of safety practices in industrial environment was an added advantage. And of course trying some Austrian Mozartkugeln and German beer was a great experience as well.

Prahlad Tewari

Q: How did you address challenges that you faced over the project period in working with the companies?

PT: Throughout the project period the European experts held refresher sessions and team workshops for me and the other consultants here in India. This was very helpful to address specific questions that had come up in the work with the companies. It also fostered the exchange between the consultants operating in different locations and peer-learning from each other. For very specific technical questions we could always consult with the senior technical experts here in India or in Europe. In terms of communication, we also faced difficulties in the beginning as it was tough to get hold of our companies at some points. We could solve this problem by creating Whatsapp groups through which we communicated with the member companies.

Q: What was your personal highlight during the project?

PT: Now that the project has come to an end, of course seeing the savings that we have achieved is very rewarding. But besides the mere numbers it has been great to build so many friendships with the people that we worked with in the companies. Experiencing how the sometimes reluctant attitude of some of our clients changed into an interested and ambitious mind-set on a professional level and to friendships on a personal level in some cases has been my highlight. It was also a very heartening experience to observe the willingness of workers to learn and adopt RECP measures in their respective companies after attending RECP training workshops organised specifically for them.

Q: What are you doing now that the project has ended?

PT: Well, I am still working on RECP topics in other projects. And as part of the ACIDLOOP initiative we are of course still offering our services to metal finishing companies that are looking for RECP improvements. This allows me to continuously make use of the rich experience that I was able to gain during the project. I look forward to expanding the horizon of RECP activities amongst various new clients.

INTRODUCTORY WORKSHOPS

In August and September 2012 a total of 13 introductory workshops were held in twelve different locations in all three project regions. The workshops targeted MSMEs engaged in metal finishing operations and aimed at attracting the companies to participate in the ACIDLOOP project. Of the 664 companies that registered for the introductory workshops, eventually 385 companies actively participated. The workshops comprised presentations on the project itself, some background on the concept of RECP as well as examples on acid and rinse water recovery measures. After the workshops, a total of 299 companies expressed their interest to participate in further ACIDLOOP project activities. The project team selected a total of 106 companies that would then receive intensive consultancy services on RECP over the project period.

Audience during introductory workshop

	Companies attending intro-workshop	Companies applied	Companies participating in project
North	84	66	34
West	207	173	48
South	94	60	24
Total	385	299	106

From the very start of the project, it was a crucial step to liaise with the local industry associations. The associations made the opening statements in the introductory workshops and presented the ACIDLOOP project team. The good relation with the local associations at the various locations ensured that the metal finishing MSMEs trusted the project team. It also contributed to the dissemination of the project results among those members of the association who were not one of the participating 106 companies.

Panel at introductory workshop

Introductory workshop

MAJOR WORKSHOPS

In comparison to the introductory workshops, attendance at the major workshops was by invitation only. Participation was restricted to those companies that had been selected to receive direct support on RECP. Between 2013 and 2015, the ACIDLOOP project team organised five major workshops series, each being implemented in all three project regions.

The first round of major workshops took place in April and May 2013 and addressed:

- in-depth information on the RECP concept
- specific RECP options for different companies
- financing options of RECP measures
- detailed information on water management
- the concept of material flow analysis

In November and December 2013, **the second round** of major workshops took place and covered:

- energy management in companies including details on energy saving potentials in process bath heating, compressed air systems, ovens and furnaces, as well as lighting
- the RECP toolkit developed by the ACIDLOOP project team

The third round of major workshops was held in June and July 2014 and addressed:

- how to develop indicators and how to establish in-company monitoring practices
- best practices for achieving more RECP in electroplating processes
- how to improve workplaces through the “5S”-approach

The participants of the third round of major workshops were given the opportunity to present to their peers the progress made in implementing suitable RECP measures in their own companies. The workshops thus facilitated learning amongst the participants and the exchange of good and best practices.

The fourth round of major workshops was held in May and June 2015 and covered the following topics:

- showcasing of implemented RECP measures
- company wise prioritisation of RECP measures
- identification of additional saving potential (low cost/no cost)
- continual improvement of existing RECP measures
- motivation of workers
- monitoring and measuring of RECP benefits

The fifth round of major workshops was held from August-October 2015 and targeted training of workers on RECP concepts, benefits and examples.

Participants during an exercise

Participants during an exercise

MINOR WORKSHOPS

The minor workshops followed an even more practice-oriented approach than the major and introductory workshops. They aimed at a wider dissemination of the experiences with the three demonstration units, i.e. technologies related to nanofiltration, diffusion dialysis and retardation.

Explaining one of the demonstration plants during a minor workshop in the North

To achieve familiarisation with the specific unit and its operation, the workshops commenced with the demonstration of the systems. Then, performance results were shared and discussed among the participants. For those companies that were not able to travel to the demonstration site, suitable trainings materials (e.g. videos) were developed.

The installation and demonstration of the three newly developed technology systems began in November 2013 in all project regions. Throughout the project, the three technology demonstration units rotated among the project regions.

Plant	Locations
Diffusion Dialysis	CHENNAI — Sri Meenakshi Enterprises MOHALI — Aqua Systems Pvt. Ltd. GURGAON — Evershine Finishers
Acid Retardation	PUNE — Abhijit Industries & Electroplaters AHMEDABAD — Monika Udyog
Nanofiltration	FARIDABAD — Common Effluent Treatment Plant Faridabad Electroplating Zone CHENNAI — Electroplating and Metal Finishers

THE RECP CAPACITY BUILDING TOOLKIT

For the training of companies as well as local consultants, the ACIDLOOP project team has developed a comprehensive training approach. The modular approach covers all relevant aspects of RECP and can be used for different target groups to train them on RECP background and RECP practices. The training toolkit comprises four different modules: RECP Assessments, RECP Interventions, RECP Motivation, and RECP Management Systems.

MODULE 1

Module 1 "RECP Assessments" is divided in different sections - it contains materials on how to assess in which areas there are RECP improvement potentials in a company. There are materials for different elements of the assessments: on the development of site- and eco-maps, flow diagrams, input-output-analyses as well as conducting material flow analyses (MFA) and cause diagnoses. There is also a sub-module on the development of RECP improvement options.

There is another set of materials which focuses on assessment specifics relating to a particular resource. The module contains materials for water, energy and waste which provide clear guidance on how to assess problems

MODULE 2

Module 2 "RECP Interventions" goes a step further and presents specific improvement options for the areas of energy, water and waste. The options presented for these areas are quite general and can be applied to almost any industrial sector. There are also specific materials dedicated to the metal finishing sector in which RECP measures for the electroplating process are presented.

MODULE 3

Module 3 "RECP Motivation" aims at the company management. It contains sub-modules on business processes in a company related to and affected by RECP.

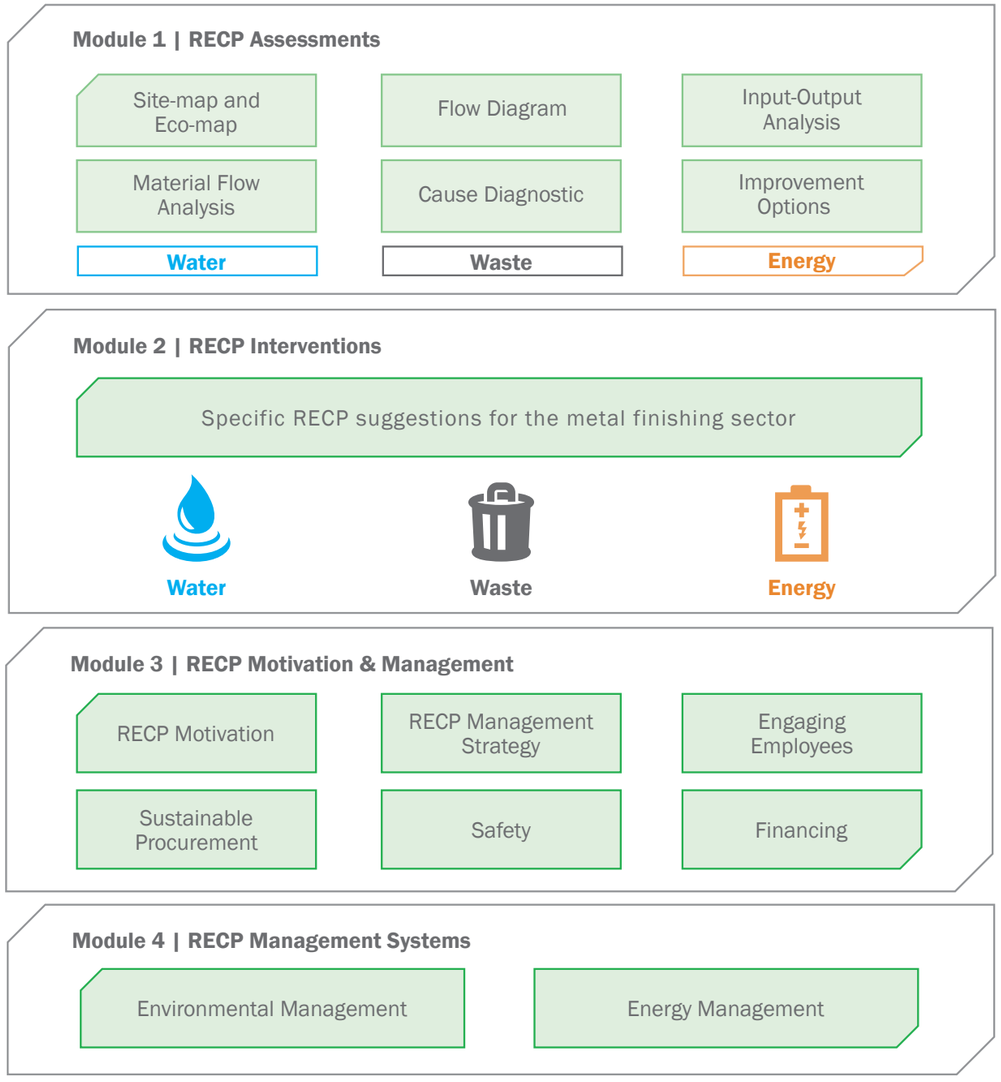
The module has a submodule on the motivation for RECP that can be used to sensitise managers and workers on what RECP means and why it matters. There are additional submodules for developing an RECP management strategy, engaging employees, sustainable procurement, ensuring safety in the company and securing financing for RECP measures.

MODULE 4

Module 4 "RECP Management Systems" presents details on energy as well as environmental management systems. Although similar to the general RECP approach, management systems such as EMAS, ISO 14.001 or ISO 50.001 require certain standards to be met. The presentations in this module provide guidance on what is required for obtaining a certification in these management systems.

The entire training toolkit employs a case study concept. The exercises that accompany every presentation always relate to a fictitious case study from the metal finishing industry. This allows the target audience to relate all tools and approaches to a company situation. This interactive training approach is designed in a way that allows for the easy modification of the case company to account for the specific context in which the training is given. The modular approach for the training makes it possible to adjust the training to the needs and interests as well as the availability of the target audience.

OVERVIEW OF MODULES



Direct Company Support

DIRECT COMPANY SUPPORT APPROACH

Following the introductory workshops in the beginning of the project, 299 companies submitted an application to join the project. To select around 100 participating companies for the project from the interested companies, company selection criteria were prepared, reviewed and finalized. Factors such as scale of operation, management structure, resource use, effluent and waste generation, as well as customers and data availability were considered to select the companies. Detailed data collection templates for understanding the current resource use by companies were finalized and the corresponding data collection was initiated. Based on data collected, a total of 96 companies were shortlisted and 17 companies were waitlisted in the beginning of the second year. During the third year, additional companies were included as few of the previously selected companies did not actively participate in the project activities.

Discussing RECP improvement potential during company visit

For each of the selected companies, a counterpart was assigned from the local teams. In the second year, the companies were visited by the counterpart and a representative from the European partners. Based on the prior data collection and the visits, status reports for individual companies were prepared. The company-specific reports included recommendations for implementation of RECP measures. To assist in preparation of the reports, a “master list” of recommendations was prepared and distributed to help local teams to cover the large number of improvement opportunities in the companies. The detailed visit report prepared for each company was personally handed over to the respective company management and the improvement potentials in the company were explained in detail. The number of participating companies (companies that have been provided visit reports) totalled 106.

To support the companies in implementing the recommendations provided in the visit reports, a list of solution providers was developed and uploaded to the project website. Additional potential improvement options were identified through literature review. On-site support was provided to companies for the implementation of improvement recommendations.

Implementation of recommendations by companies was continuously tracked through follow-up with companies through visits and over email, phone calls and WhatsApp. This was carried out by the local teams led by the counterparts. The progress of the companies in implementing the measures was captured in periodic monitoring reports. European experts were involved in consulting for specific topics e.g. mass flow analysis for raw materials water and powder (used in powder coating units). The initial emphasis of the measures implemented was on low-cost or no-cost measures. The short pay-back period and savings from these measures motivated the companies to implement additional measures. This indicated a gradual change of the mind-set of companies towards RECP. Support was also provided based on specific queries from the companies. This included, for example, the design of a water cascade system for a rinse water line in Mohali, conducting a specific mass flow analysis for a unit in Gurgaon, or the design of a waste heat recovery system in Ahmedabad. Showcases were prepared based on successful implementation of measures in the companies. Examples of RECP measures implemented under the project are shown in a subsequent section.

Measuring resource consumption during site visit

INTERVIEW WITH MR. ANIL PATIL FROM SHRIRAM ENGINEERS

Owner of a metal finishing company participating in the ACIDLOOP project

Q: When was the first time you heard of the Resource Efficient Cleaner Production (RECP) approach? Were you familiar with the concept before your participation in the ACIDLOOP project?

AP: Being an MSME, we were not aware about RECP. We got acquainted with this concept after the inception of ACIDLOOP project in August 2012.

Q: How did you and your company benefit from participating in the ACIDLOOP project?

AP: First of all, we are very thankful to the entire ACIDLOOP team. Not only has our business manoeuvred through a generally difficult economic situation without much harm, we have also managed to grow and increase our capacity. We have saved lot of money by saving water and chemicals. After implementing the ACIDLOOP team’s recommendations, we approximately saved 30% of water, and 20 – 25% of chemicals. This increased our profits. Our workforce also received training on latest available techniques regarding energy savings and the efficient operation of machinery.

Anil Patil

Q: What was the biggest challenge you met while implementing RECP in your company?

AP: That’s a very good question. The biggest challenge we faced was collecting the data. Previously, we were working haphazardly. We did not have any record for our electroplating process. And most of the electroplating MSMEs also do not have such data. After the inception of this project, we learnt how to collect the data, interpret it and to use it to improve our processes. This was possible through the training given by the ACIDLOOP team.

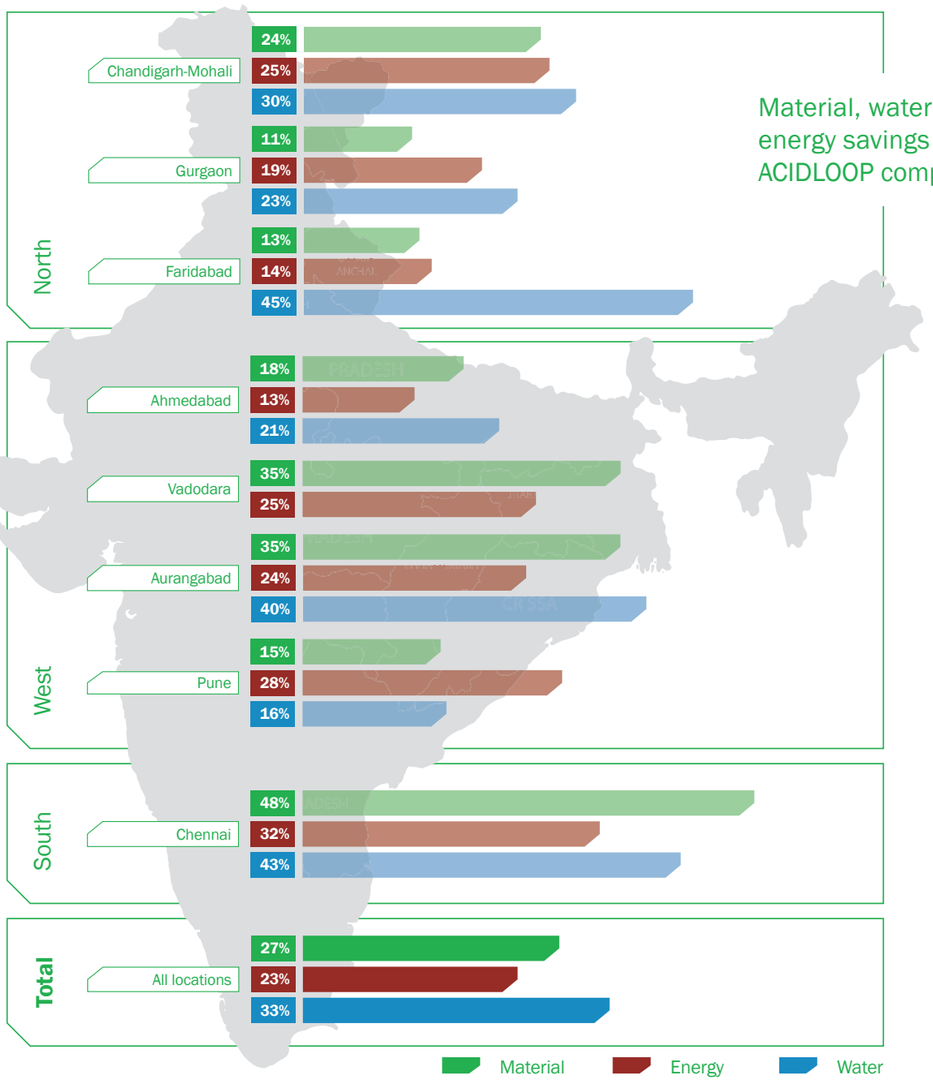
Q: How did your staff react to your decision to participate in the ACIDLOOP project and the changes you implemented throughout the project?

AP: Our staff strongly supported the implementation of the ACIDLOOP team’s recommendations. They very much enjoyed and benefitted from attending the training programmes conducted by the ACIDLOOP team. They were also enthusiastic about implementing the suggested recommendations.

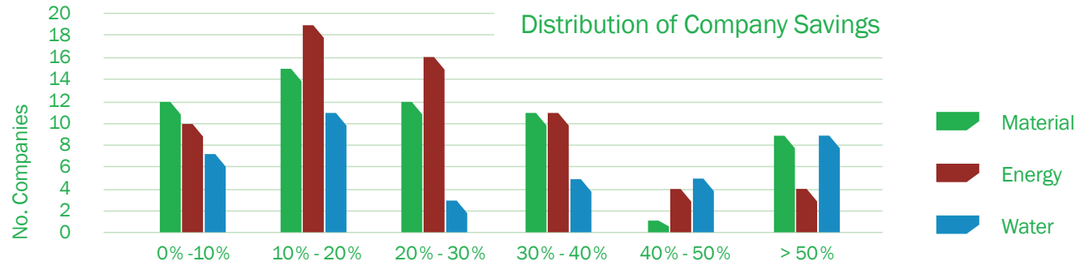
KEY RESULTS OF THE DIRECT COMPANY SUPPORT

Showing the impact of the ACIDLOOP approach was very important from the beginning of the project. During the first assessment of companies, the ACIDLOOP consultants therefore collected data on what amount of resources the company was using, and how much energy and water it consumed. This consumption data was correlated with the production output.

At the end of the project period – after the RECP measures identified had been implemented by the companies – the consultants again measured the consumption of input materials per output produced (specific consumption). The ACIDLOOP team is very proud to have achieved significant savings in specific consumption of input resources across all regions. As can be seen in the figure below material, energy and water consumption decreased on an average by more than 20% in all regions.



Material, water and energy savings of ACIDLOOP companies



SUCCESSFUL RECP MEASURES

A wide variety of RECP improvement measures was suggested to the companies over the course of the direct engagement phase. Many measures were then implemented by the companies in close consultation and cooperation with the local counterpart.

On the following three pages, we would like to present you some of the measures that we have implemented during the ACIDLOOP project. Many more good and best practices can be found in the Good and Best Practice Module for RECP Measures in the Metal Finishing Sector.

Replacement of Wires with Jigs in Plating Baths

Location: Faridabad | Process: Electroplating

Before: Steel wires were used for hanging the metal parts to be plated in the electroplating bath. Problems associated with this approach included:

- Steel wire was consumed during plating.
- Loading of parts to be plated was time consuming.
- The orientation of the parts could not be controlled.

After: The ACIDLOOP team suggested the replacement of all steel wires with reusable jigs. Benefits from this approach included:

- The time required for loading was reduced which increased the productivity.
- The orientation of parts could now be controlled which improved the quality of the plating process.

Rs. 1,00,000 for hangers

Rs 84,000 from reduced costs for wires and less product losses

14 months

Cost and benefits:

Costs of interventions

Annual savings

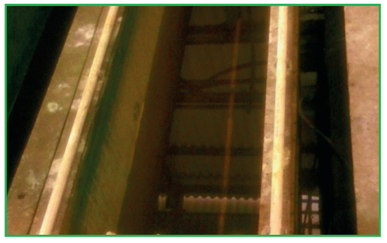
Payback time

Installation of drain boards to avoid chemical spillages and bath contamination

Location: Pune | Process: Electroplating

Before: Tanks of an automated plating line were installed next to each other with a small space in between. This led to the following problems:

- Baths were contaminated rapidly as too much of the liquid from one tank was carried along to the next tank when the parts were moved. Baths had to be replaced every 20 days.
- A lot of spillage occurred in the gap between the tanks when the parts were moved from one tank to another.



After: The ACIDLOOP team suggested the installation of drain boards between the tanks. Benefits from this approach included:

- With the sloped shape of the boards, drag-out went back to the tank where the parts came from instead of contaminating the bath or water in the next tank. As a result, the time which a bath could be used increased by 50% to 30 days.
- Less spillage occurred and the floor became much cleaner and less slippery.

Rs. 20,000 for installing the boards

Rs 1,18,000 from reduced replacement time for baths

2 months

We are very thankful to the entire ACIDLOOP team. We have saved lot of money by saving water and chemicals. After implementing the ACIDLOOP team's recommendations, we now consume 30% less water, and 20 – 25% less chemicals which significantly increases our profits.

Mr. Anil Patil
from Shriram Engineers, a metal finishing company

Installation of a water cascading system

Location: Aurangabad | Process: Electroplating

Before: The company had been operating a manual rinsing line. Plated parts were washed in one tank and then taken to the next processing step. This resulted in the following problems:

- A lot of water was consumed as the water in the rinsing tanks had to be replaced on a daily basis.
- A lot of spillage occurred which led to a wet floor as well as wastage of water.

After: The ACIDLOOP team suggested the installation of multiple cascading rinsing tanks. With the cascading approach, plated parts enter a first tank for rinsing, then a second, third and even fourth tank. The tanks are interconnected with an overflow mechanism. Water from the fourth step flows into the third which flows in the second and so forth. Benefits from this approach included:

- Water consumption and waste water generation can be significantly reduced as fresh water is only added to the fourth tank. Large parts of the acid are already washed off in the first and second stage and the parts are then washed clean in the final steps.

Rs. 10,000 for pipe fittings

Rs 1,08,360 from reduced water consumption

1.1 months

Insulation of heated baths with polypropylene balls

Location: Mohali | Process: Electroplating

Before: The plating baths were not covered. This led to the following problems:

- Heat loss occurred from the surface of the bath and more electricity was required for maintaining the bath temperature.
- Loss of water occurred due to evaporation from the surface.

After: The ACIDLOOP team suggested to use polypropylene balls for covering the surface of the bath. Benefits from this approach included:

- A reduction in energy, water and chemical losses from the surface of the bath.
- It became easier to maintain a uniform temperature in the bath with positive effect on plating quality.
- The working environment was improved as there were less acrid fumes emitted from the bath.

Rs. 8,000 for the polypropylene balls

Rs 1,00,000 from energy, water and chemical savings

1 month

Technology Development

Acid, water and liquid waste are significant cost factors for metal finishing enterprises. Used acids and rinsing waters contain heavy metals. If they are not properly treated before discharge, contamination of surface waters and groundwater can occur. Furthermore, discharge leads to the loss of valuable resources. It was one of the ACIDLOOP project goals to develop technical solutions for the recovery of used acids and rinsing waters in Indian metal finishing companies. For that purpose, TERI together with BFI developed three demonstration plants based on:

- diffusion dialysis,
- retardation, and
- nanofiltration.

These technologies are usually applied at large to medium sized plants in industrialised countries in order to recover valuable resources from waste acid and rinsing water. The aim was to show their applicability in Indian small and medium size companies (or as a solution for common effluent treatment plants) considering climatic conditions, operational stability and economic feasibility. In order to demonstrate the technologies to several companies in the three project regions, each demonstration plant was operated at two or three different locations.

BACKGROUND

REUSE OF ACIDS

Surface treatment of metals in plating lines usually includes acid pickling. During pickling, impurities and metal oxides are removed by chemical reaction with the pickling solution. Subsequently, the fraction of active acid in the pickling solution decreases while the metal ion concentration increases. At low active acid concentrations the pickling velocity slows down and the process cannot be operated efficiently. Furthermore, when the solubility product is exceeded, iron salts precipitate plugging the pickling tanks. Thus, for efficient operation a part of the pickling bath has to be disposed and fresh acid has to be added. The disposed acid contains active acid that could be reused if the metal ions are separated. Acid reuse would lead to:

- resource and monetary savings (due to savings on fresh acid and neutralization chemicals),
- reduced landfill volume and costs (as only a part of the spent acid is neutralized), and
- improved environmental conditions (due to a reduction of salt emissions).

The recovery of active acid from used acid can be performed by membrane filtration or ion exchange. In addition to the environmental aspects, a continuous regeneration of the pickling acids lead to better pickling results enhancing the surface quality of the products.

REUSE OF RINSING WATERS

Plating lines usually include several surface treatment steps with intermediate rinsing. In order to reach high product quality, demineralized rinsing water is usually used. During rinsing it washes off surfactants, salts and metal ions from the metal surface. The used water is usually neutralized to precipitate the metal salts and then discharged. Alternatively, the metal ions and salts can be separated by nanofiltration or reverse osmosis. The permeate can be reused for rinsing. The concentrate can be either neutralized and discharged or reused in the plating bath. This leads to reduced fresh water consumption and waste disposal.

DEMONSTRATION PLANTS

In the ACIDLOOP project, we demonstrated the applicability of two acid recovery technologies (diffusion dialysis based on membrane filtration and retardation based on ion exchange) as well as one technology for rinsing water reuse (nanofiltration). The demonstration plants were operated in the three project regions with various acids and different rinsing water qualities. The aims were:

- to evaluate the applicability of the selected technologies in the Indian metal finishing industry,
- to show that acid and rinsing water reuse have economic and environmental advantages, and
- to teach the personnel how to use these technologies efficiently.

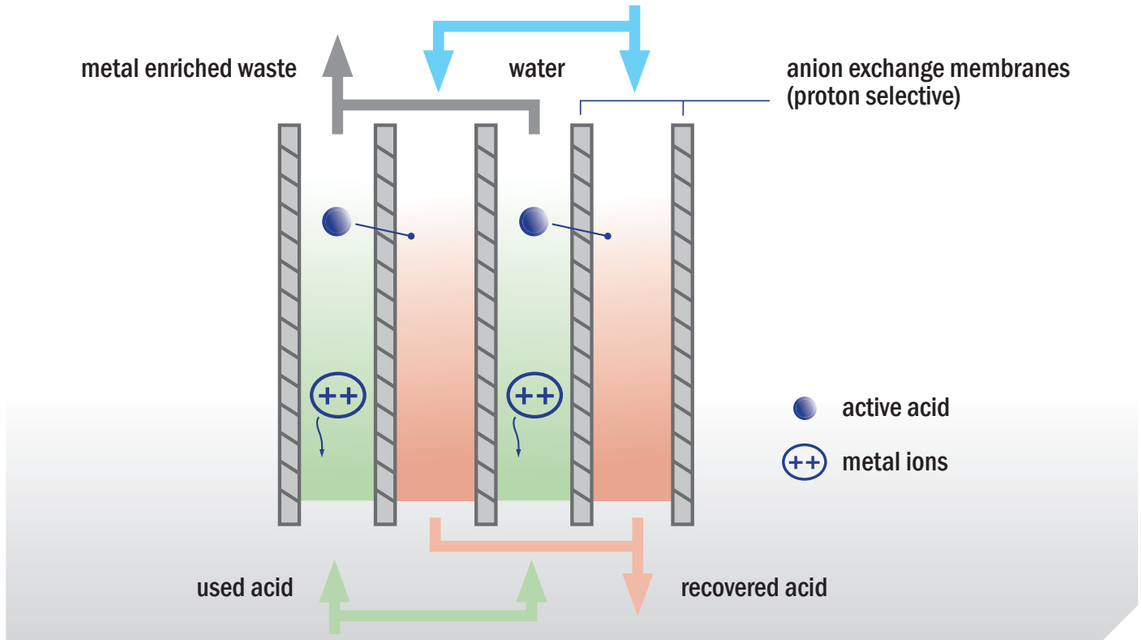
DESCRIPTION OF THE DEMONSTRATED TECHNOLOGIES

DIFFUSION DIALYSIS

Diffusion dialysis is a membrane separation process operated without external pressure. Its driving force is a concentration gradient on either side of a non-porous anion exchange membrane. The diffusion dialysis membrane stack consists of a multitude of compartments formed by alternating spacers and anion exchange membranes allowing acids to permeate but retaining dissolved metals due to their electric charge.

Mounting of diffusion dialysis stack in Chennai

In diffusion dialysis stack, spent acid enters the bottom of every alternate compartment, while deionized water is fed countercurrent from the top of the stack (see figure below). Free acid passes through the membrane while the metal ions are retained. Around 80-95% of active acid can be recovered. The recovered acid is collected from the bottom of the stack. The depleted feed (dialysate) leaves the top of the stack as an effluent containing high concentrations of metal salts and a low concentration of remaining acid. Due to its specific geometry, the stack is susceptible to clogging by particles and oils. Thus, an appropriate acid pre-treatment that includes efficient oil separation and particulate removal is crucial for long-term stability of the process.



Scheme of diffusion dialysis stack

RETARDATION

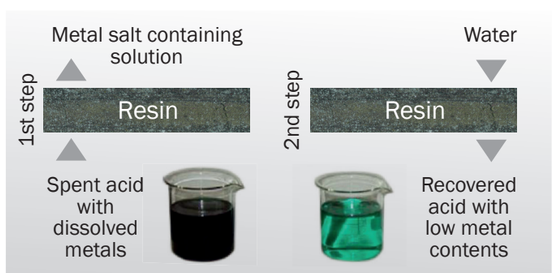
Retardation is an acid regeneration process based on ion exchange. The retardation process comprises two steps:

- sorption of acid on the ion-exchange resin, and
- desorption of the purified acid with deionized water in a counter-current flow.

The resin bed absorbs only the active acid while the metal ions and a part of the acid pass through the resin bed, forming a waste solution. The latter is usually neutralized and discharged. The absorbed acid can be washed down with water. One cycle typically takes about 2-5 minutes. The recovered acid can be recycled in the pickling bath.

Operation of retardation plant in Pune

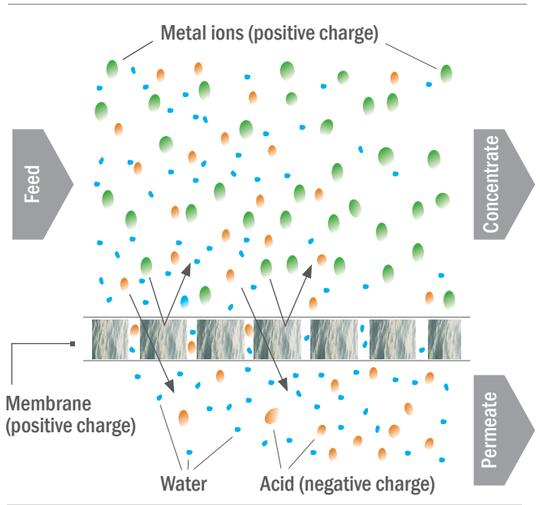
Around 80-90% of the free acid can be recovered from the used acid. The acid recovery rates of retardation are a little lower than for diffusion dialysis, but the resin is cheaper than the membranes. It is also easier to replace. For efficient operation of retardation the used acid should be free of particles and oils. Usually this requires pre-treatment by microfiltration and oil separation.



Scheme of retardation

NANOFILTRATION

Nanofiltration is a pressure driven membrane separation technique operating at 10-50 bar. The separation ability depends on steric effects (sieving), diffusion and electric repulsion due to electrically charged functional groups on the membrane surface. Polymeric nanofiltration membranes are typically negatively charged in neutral and alkaline solutions and positively charged in acid solutions. Therefore, during the filtration of acidic rinsing waters the separation is mainly influenced by the rejection of cations and the attraction of anions. Thus, acid permeates and metals are rejected. The scheme of nanofiltration is shown in the figure below. Nanofiltration can be applied for all kinds of rinsing waters. The influent should however be free of particles and oils.



Scheme of nanofiltration

With reverse osmosis even higher permeate quality can be achieved than with nanofiltration because all ions are retained. The disadvantages of reverse osmosis membranes are low permeability. That means that for the same flow, larger membrane surface and/or higher pressure is required than for nanofiltration.

Nanofiltration in Chennai

CASE STUDIES WITH DEMONSTRATION PLANTS IN INDIA AND RESULTS

The demonstration plants with the treatment capacity of 20-150 l/h were operated at various metal finishing facilities around India. Diffusion dialysis and retardation were implemented for the recovery of various acids. Nanofiltration was applied for rinsing water reuse and rinsing water production from secondary sources.

PRE-TREATMENT OF USED ACIDS AND RINSING WATERS

The used rinsing waters and acids usually contained up to 2 g/l oils. This resulted from insufficient degreasing or failed degreasing bath regeneration. The final degreasing occurred in pickling baths. Oil contamination of pickling baths reduces their efficiency and leads to increased acid consumption. Furthermore, oil contamination can result in malfunction of acid regeneration technologies. None of the demonstration plants could be continuously operated with oil concentrations above 50 mg/l because of expected membrane fouling and blocking of the ion exchange resin. For the influent, pre-treatment oil separators were introduced. They worked well for neutral rinsing waters but could not separate the oils emulsified in acids. The oils led to the reduction of flow in the diffusion dialysis plant from 20 l/h to 7 l/h and to the reduction of the active acid recovery rate in the retardation plant. Thus, good functioning degreasing bath in metal finishing lines are essential for efficient acid regeneration and rinsing water reuse.

Technology	Location	Objective
Diffusion dialysis, 20 l/h	Chennai (South)	Regeneration of hydrochloric acid from a pickling bath of a zinc plating company
	Mohali (North)	Regeneration of sulphuric acid from activation bath of a plating process
Retardation, 50 l/h	Pune (West)	Regeneration of hydrochloric acid in a plating company
	Ahmedabad (West)	Regeneration of mixed acid ($HF+HNO_3+H_2SO_4$) in a pickling process
Nanofiltration, 150 l/h	Faridabad (North)	Filtration of the effluent of a common effluent treatment plant to produce rinsing water
		Filtration of rinsing water from passivation bath for permeate and concentrate reuse
	Chennai (South)	Filtration of rinsing water from zinc plating for reuse

DEMONSTRATION OF DIFFUSION DIALYSIS

In spite of oil contamination of the acids and reduced flow, the demonstration plant for diffusion dialysis reached active acid recovery rates of 78-86%. The plant was easy to operate and did not require high pressure pumps. It was considered suitable for large as well as for small metal finishing companies. Current challenges for the implementation of diffusion dialysis in Indian metal finishing MSMEs include high membrane costs and limitations of oil content in the effluent.

DEMONSTRATION OF RETARDATION

In the demonstration plant for retardation, the active acid recovery rates were around 50%. It was below the rates shown by diffusion dialysis. The low recovery rates compared to the theoretical 80-90% could be explained through the oil contamination of the resin surface. The flow was not reduced by the oil accumulation considerably because the resin bed could be washed through more easily than the diffusion dialysis membrane stack. The active acid recovery rates were too low. For higher recovery rates, the retardation cycle has to be optimized. In order to achieve this, reliable chemical analysis of active acids and metal ions is required. In India there is still a gap in reliable analytical service in this area.

DEMONSTRATION OF NANOFILTRATION

The demonstration plant was operated with rinsing waters with conductivities of 8-10 mS/cm. The obtained permeate with conductivity of 0.5-0.6 mS/cm could be reused for rinsing. For the reuse of the concentrate, reliable analytical support was missing. During operation, the flow was reduced by approximately 50% due to membrane fouling by precipitating calcium sulphate and zinc hydroxide. As nanofiltration membranes are available in India at acceptable costs, they can be easily replaced. The technology acceptance for nanofiltration in the companies was high because membrane filtration was already known from drinking water treatment.

LESSONS LEARNT

The successful operation of the demonstration plants proved the applicability of diffusion dialysis, retardation and nanofiltration for the reuse of acids and rinsing waters in the Indian metal finishing MSMEs. The following challenges for the implementation of these technologies were identified:

- Oil contamination of acids and rinsing waters,
- High investment costs,
- Lack of reliable chemical analytical support for measuring active acid and metal content,
- Lack of trained personnel to operate the unit which is a key prerequisite for a successful operation of the plant, and
- Lack of proper documentation of chemical usage.

Oil contamination can be avoided by the optimization of degreasing baths. A well operated degreasing bath will also lead to reduced acid and rinsing water consumption. High investment costs can be reduced if the plants are produced in India and not in Europe. The demonstrated technologies are basically known to the local plant producers; therefore it should be possible for them to construct plants for the Indian market. Another possibility is to build large plants treating acids and rinsing waters from several companies. This centralised approach will reduce specific investment and operational costs. Furthermore, such plants can employ competent specialists providing reliable plant operation as well as good chemical analysis.

CHAPTER 7

Dialogue and Stakeholder Engagement

THE ROLE OF STAKEHOLDERS IN THE ACIDLOOP PROJECT

Enterprises alone cannot bear all the responsibility for transitioning the metal finishing sector towards more RECP practices. To account for this, the ACIDLOOP project engaged with different stakeholders in the broader framework of the metal finishing sector to make them aware of the merits of RECP and encourage them to support metal finishing MSMEs in taking up RECP practices. The four most important stakeholder groups in terms of its relevance for the metal finishing sector are:

Public authorities	**Public authorities** and specifically environmental authorities enforce the legal framework all Indian MSMEs operate in. They oversee the adherence to environmental regulations and can sanction non-compliance. They also have the potential to disseminate knowledge on RECP practices among metal finishing MSMEs thereby acting as facilitators rather than enforcers. The ACIDLOOP project engaged with relevant public authorities through a series of policy dialogues.
Technology suppliers	**Technology suppliers** play an important role in making the technological solutions available that are required for some RECP measures. Although the focus of an RECP strategy should first be on no- and low-cost options, some saving potentials can only be realised with suitable technology. By disseminating such technologies, the suppliers can contribute to RECP in the metal finishing sector. To facilitate this dissemination, the ACIDLOOP project has organised technology supplier roundtables and fairs that promote the mutual understanding between metal finishing MSMEs and technology suppliers.
Customers	**Customers** are the key external actors for MSMEs as they have more influence on the MSMEs than any of the other stakeholders. If a customer or even better – a group of customers – demands that a certain standard is applied, the companies are very likely to comply as they risk losing business opportunities. Therefore, the ACIDLOOP project has organised customer roundtables to promote a better understanding of customers on RECP and to facilitate the exchange of needs between metal finishing MSMEs and their customers.
Financial institutions	**Financial institutions** have a great potential to support India's metal finishing industry in adopting RECP practices and measures. So far, this potential has only been exploited insufficiently as most financial institutions had little or no information on the financing needs and the innovative potential of MSMEs. The ACIDLOOP project contributed to building bridges between MSMEs and their local financial institutions and to sensitise financial institutions' general management on funding needs for RECP measures.

ENGAGING THE PUBLIC SECTOR

By engaging with different policy stakeholders as well as public authorities, the ACIDLOOP project aimed at initiating better framework conditions for metal finishing MSMEs' efforts to invest in RECP. To discuss which specific conditions were of relevance, a first set of policy dialogues was held at the beginning of the project, in August 2012, in all three project regions.

The overall goal of these events was to develop a common understanding of the challenges and opportunities in India's metal finishing sector among all participants and the institutions they represented. The first round of exchange during these policy dialogues came to the conclusion that a sufficient number of laws and regulation were in place to provide for uptake of RECP in the metal finishing sector and that relevant technologies and know-how were also readily available. However, the uptake of technologies and new management systems is slow. Other existing problems are the lack of communication between the pollution control boards and other stakeholders, MSMEs especially, as well as insufficient recognition of research institutions in the overall framework for technology transfer.

International panel during policy dialogue

As a follow-up of the regional policy dialogues, the ACIDLOOP project team developed a policy report that compared the system of technology transfer in India and Germany. The findings from this report were used to formulate a policy brief with recommendations on how to improve technology transfer from India's public research institutions to metal finishing MSMEs. Both policy report and the policy brief have been updated in 2014. The policy recommendations on technology transfer as formulated in the policy brief are:

- Cooperation between the different stakeholder groups needs to be improved for a successful transfer of technologies from the research stage
- Awareness must be created at the level of MSMEs that technologies exist that enhance the production processes
- Support programmes need to be tailored specifically to the needs of the metal finishing sector
- Funding needs to be increased for technology transfer and applied research in general and the metal finishing sector in specific

In September 2014, the policy dialogue was shifted from the regional to the national level and a National Policy Dialogue was held in New Delhi. Participants in this event included representatives from government institutions, research institutes and industry associations from Chandigarh, Gandhinagar, Gurgaon, Karaikudi, Moradabad and New Delhi.

Group discussion during policy dialogue

During the National Level Policy Dialogue, experts from India and Germany gave presentations on the Indian and German policy framework for technology transfer. Based on these inputs, participants discussed ways of improving the technology transfer conditions in India. Recommendations included, among others, to support joint applications of MSMEs for funding on research and development, to establish expertise on technology transfer at cluster-level or among the associations and to create linkages between MSMEs and to establish funding schemes for technology transfer at the national level.

ENGAGING TECHNOLOGY SUPPLIERS

Working with technology suppliers was based on the objective to make RECP technologies available to MSMEs of the Indian metal finishing sector. It was the goal of this activity to identify needs of metal finishing MSMEs regarding access to technologies as well as needs of technology suppliers regarding access to MSMEs as customers. A common problem across all three project regions had been that MSMEs had not been an important/interesting market for many technology suppliers in the past.

Engagement with technology suppliers was initiated through two preliminary dialogues: at the WaterTech Expo & Conference that took place on 28 September 2013 in Gandhinagar and at the Advantage Maharashtra Expo that took place from 2-5 January 2014 in Aurangabad. Those events were used to establish first linkages with technology suppliers.

Technology suppliers and MSMEs discuss cooperation

The first actual technology supplier roundtable and fair, however, was held on 8 October 2014 in Mumbai and followed a broader approach. MSMEs from India's metal finishing sector constitute a market that has hardly been penetrated by Indian and European technology suppliers. Therefore, the roundtable organised by the ACIDLOOP project brought together MSMEs from India's metal finishing sector and technology suppliers to explore options of cooperation. Participants from 23 technology suppliers and metal finishing association representatives from Ahmedabad, Aurangabad, Chandigarh-Mohali, Chennai, Faridabad, Gurgaon and Pune met in Mumbai. The first half of the day was dedicated to a roundtable event with presentations and group discussions. Key points that emerged during the presentations and discussions included:

- MSMEs expect a quick return on investment; this often prevents them from investing in technologies with relatively high capital and operating costs
- MSMEs expect technology suppliers to offer training and after-sales support
- Technologies are required to work under variable operating conditions
- MSMEs are reluctant to switch to new technologies due to lack of awareness and lack of information (e.g. on quantified benefits of new technologies)
- Implementation of new technologies is generally perceived as being cost-intensive
- MSMEs lack human capacity and analytical ability to operate new technologies.

The second half of the day was designed as a technology fair that allowed first hand interaction between metal finishing MSMEs and technology suppliers.

Further events on cooperation with technology suppliers took place as joint industry – technology supplier – financing dialogues and are covered in the section on financial institutions below.

ENGAGING CUSTOMERS

Customers are the key external actors for companies. Therefore, the ACIDLOOP project engaged with the metal finishing MSMEs' customers, including both the companies' direct customers and "customer bodies". "Customer bodies" refers to the respective customer associations and research institutions. The most relevant direct customers for the metal finishing companies that we worked with were automotive manufacturers and producers of bathroom fittings. Those two target groups were addressed during two customer roundtable events that were held in 2014. The roundtables had a regional focus and took place in Chennai as well as in Chandigarh-Mohali in September 2014. The overall aim of these half-day events was to sensitise customers for the necessity and potential of adopting a greener supply chain by buying from those metal finishing MSMEs that invest in RECP practices and measures.

Customers benefit in at least two ways from relying on "greener" metal finishing MSMEs as their component suppliers: First, a greener supply chain can significantly improve a company's potential to export their goods (e.g. cars, bathroom fittings) to markets outside India. Secondly, RECP measures

have the potential to reduce production costs in the metal finishing sector which contributes to a generally more cost-efficient production process.

Participants of the first customer roundtable in Chennai included direct customers of metal finishing MSMEs such as Brakes India and Delphi-TVS, as well as representatives from Ambattur Electroplaters Association, the Institute of Indian Foundrymen, the National Productivity Council (NPC) Chennai, and the Central Electrochemical Research Institute (CSIR -CECRI) in Karaikudi.

Discussion during customer roundtable

The second customer roundtable in Chandigarh was attended by customers and metal finishing company members from Mohali Industries Association as well as representatives from local government institutions and scientific research institutions. The roundtables were designed to bring together the different stakeholders and to discuss ways to improve their cooperation for establishing a greener supply chain for the customers. During the events, each stakeholder group developed an action plan on how to best address the others' needs. Those action plans were then presented to the plenum and all participants engaged in a discussion on how to match the different expectations between the different stakeholder groups. Discussions during the customer roundtables led to the following outcomes:

- Both metal finishing MSMEs and their customers expressed interest in continued regular interaction for a sustainable process improvement
- Customers were asked to provide technical assistance for the development of new products
- All stakeholders encourage an increased use of eco-friendly raw materials and intend to avoid using hazardous raw materials
- Stakeholders intend to engage in the construction of a common waste treatment facility

ENGAGING FINANCIAL INSTITUTIONS

Access to finance is a key element of any RECP strategy. Despite the fact that many RECP measures do not require any investment or only very small amounts of funding, some measures actually do require funds that cannot be made available from the companies' own capital. In this case, the companies rely on external funding which means access to loans in most cases. The overall goal of the financing component of the ACIDLOOP project was to facilitate MSME's access to finance for investing in RECP measures. This included informing MSMEs about financing options, improving the financing institutions' understanding for MSMEs' needs and pointing to the benefits the financing institutions themselves can expect from engaging with MSMEs from the metal finishing sector (e.g. access to new customer base).

The first round of marketing and replication events for financing institutions took place in April and May 2013. Participants invited to the events included MSMEs from the metal finishing sector and their associations and local financial institutions. As the actual technologies in which a company invests is also very relevant for their chance of receiving finance from the bank, a group of technology providers was also invited to these events.

During the events, the stakeholders expressed their view on financing RECP in the metal finishing sector and shared challenges they face in accessing funding or making funding available. From the presentations and discussions, the following specific challenges and needs were identified:

MSMEs

- MSMEs often lack knowledge and information on existing financing schemes
- MSMEs often lack the financial capacity to come up with the collateral for a loan and to pay the required interest rate
- Complicated application procedures prevent MSMEs from applying for a loan
- MSMEs would benefit from the introduction of working capital loans for short periods
- MSMEs lack knowledge on relevant technologies and their saving potential
- In case of technology purchase, improved after-sales support would be desirable (e.g. in case of technical problems).

FINANCING INSTITUTIONS

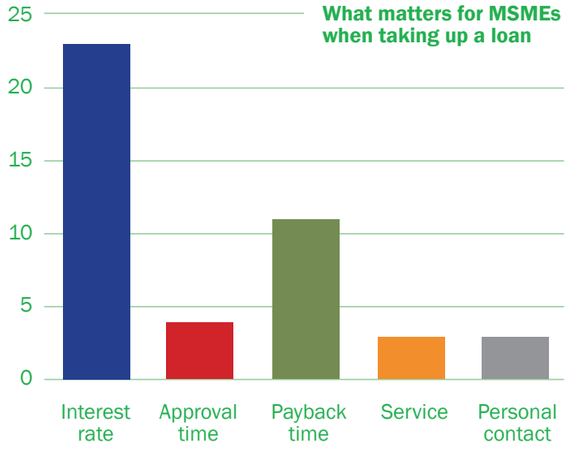
- Banks lack data from MSMEs required for assessing the risk of loan failure, including financial data, certified resource use data and information on the resource saving potential of a planned investment.

TECHNOLOGY PROVIDERS

- Technology providers face the challenge of MSMEs having very high expectations regarding the payback time of new technologies
- According to technology suppliers MSMEs also lack time and technical capacity to select and understand technology options.

Both marketing and replication events concluded with a "market place", i.e. an additional format that allowed technology suppliers and banks to present their products to MSMEs.

Based on the results of this exchange, the strategy for further engaging financial institutions was adjusted. It was decided to shift the dialogue with the technology providers to another format – the technology supplier roundtables and a technology supplier fair. Subsequent activities in 2014 focused on strengthening the link between those MSMEs participating in the ACIDLOOP project and selected local bank offices. In a first step, a survey among almost 50 MSMEs shelped to identify specific financing needs. What matters for companies when considering whether to take up a loan is displayed in the figure below.



In a second step, members of the ACIDLOOP project team visited selected local bank branch offices in order to establish personal contact with the branch officers, present the ACIDLOOP project to the banks, assess to what extent the project team could support MSMEs in filling in applications for those credit lines, and suggest RECP technology options that could be eligible for investment loans.

How savings from RECP measures can be achieved and how short the payback time for a small loan can be is demonstrated by the case study below:

COST-BENEFIT ANALYSIS OF THE INTERVENTION OF REPLACING MULTIPLE COMPRESSORS WITH ONE

An electroplating company from Chandigarh/Mohali operated six reciprocating compressors with a power rating of 60 hp each. The compressors were working for 24 hours per day.

Following the suggestion of the ACIDLOOP team, the company replaced the six compressors with a single screw compressor of 40 hp. This resulted in significant electricity savings.

The investment required for installing the new compressor was INR 5,70,000. The annual energy savings from the insulation summed up to INR 7,52,000 resulting in a payback time of 9 months.

Compressors before intervention

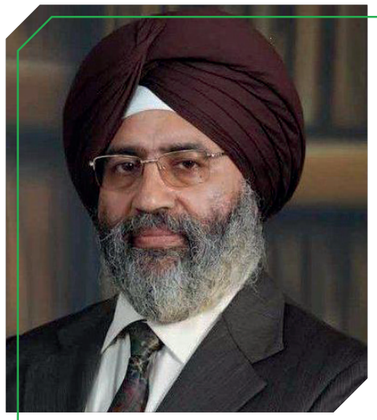
Compressor after intervention

Sustainability of the Action and Outlook

CHAPTER 8

Though the ACIDLOOP project has ended, it has been part of the project approach from the very beginning to ensure that the results endure.

Project experiences and results have been documented, edited and prepared in a way to be accessible for interested actors after the project has ended. Project materials in the form of presentations, reports, case studies and factsheets are available on the project website. This project brochure itself is a key document for sustaining the achievements of ACIDLOOP even after the project period has ended. It summarises the aims, steps taken and results of the various areas of work and presents lessons learnt.



"The ACIDLOOP project has given excellent results in the field of resource efficient and cleaner production (RECP). I personally feel that the project was very effective and beneficial. There is lot of potential for horizontal deployment of the project activities implemented in the clusters to other regions. And still there is scope for doing more activities towards RECP approach in the units, who have received training under the project"
Mr B S Anand *from Mohali Industries Association (MIA)*

Another important publication ensuring sustainability of the ACIDLOOP project is the Good and Best Practice Manual. It contains technical good and best practice options for resource efficiency measures in the metal finishing sector. It makes the technical project knowledge available in an easy-to-use manner, using for instance photos showcasing bad practices and the no-cost or low-cost resource efficiency measures implemented.

Local and national level metal finishing associations, research institutions, and public authorities have been participating in the project activities from early on. They are familiar with the approach and the results achieved and will contribute to spreading the good and best practices implemented in the project across the industry.

The capacity that has been built among the project partners' local consulting teams remains in the country. To make use of their vast experiences on working with the companies, some of the project partners have decided to form the ACIDLOOP initiative to continue offering their consultancy services to metal finishing companies in India.

Companies can directly engage with the ACIDLOOP initiative to receive tailor-made consultancy service directed at the company-specific challenges. After an initial assessment of the company, the ACIDLOOP initiative consultants will estimate expected minimum savings that can be achieved by implementing RECP measures. Only if the savings outweigh the consultancy and required investment costs in the short and medium term will the company be offered to go ahead with the consultancy.

The ACIDLOOP initiative also offers services to the wider stakeholder framework in the metal finishing sector. Trainings, workshops and dialogue rounds can be organised for public authorities such as State Pollution Control Boards or ministries, for industry associations, international donor agencies, technology suppliers or customers of metal finishing associations.

During the project, the ACIDLOOP consortium and the participating metal finishing MSMEs have jointly achieved considerable success. This success is here to stay and has the potential to inspire many other companies in the sector. The continuous interaction of the ACIDLOOP project team has also contributed to making other stakeholders more sensitive to the issue of RECP. With the support of these stakeholders – customers, government authorities, financing institutions, technology suppliers – it will become easier for companies to embark on the path of RECP.

The partners of the ACIDLOOP initiative are looking forward to continue supporting companies and the wider stakeholders in the endeavour to create a more resource efficient metal finishing sector in India.

Bibliography

Baumhakel-Schruef M., Thaler S., & Wolf P. 2006: Categories of the implemented and planned measures of RECP project (Ökoprofit® Graz) in 2006. Ökoprofit® Auszeichnung 2006, Graz

Chandra, N. 2008: Small and medium enterprises in the national system of innovation. Exploring the barriers to technology transfer. Retrieved 27.02.2013 from: http://www.business-asia.net/Pdf_Pages/Guidebook%20on%20Technology%20Transfer%20Mechanisms/SME%20in%20National%20Systems%20of%20Innovation.pdf

DNB n.d.: India's Energy Sector. Retrieved 04.03.2013 from: http://www.dnb.co.in/IndiasEnergySector/Power_Gen.asp

EPA 2012: Effluent Guidelines. Electroplating. Retrieved 01.10.2015 from: http://water.epa.gov/scitech/wastetech/guide/electroplating/index.cfm

EPA 2014: Effluent Guidelines. Metal Finishing. Retrieved 01.10.2015 from: http://water.epa.gov/scitech/wastetech/guide/metalfinishing/

Ernst & Young 2011: Water sector in India Emerging investment opportunities

Government of India 2010: Report of Prime Ministers' Task Force on Micro, Small and Medium Enterprises, New Delhi

Rawat, M., Singh, U. K., & Subramanian, V. 2012: Movement of toxic metals from small-scale industrial areas: a case study from Delhi, India. International Journal of Environment and Waste Management, Vol. 5, No. 3/4, 224 - 236

Sundaravadivel, M., Vigneswaran, S., & Visvanathan, C. 2006: Waste Minimization in Metal Finishing Industries. Retrieved 28.01.2013 from: http://www.faculty.ait.ac.th/visu/Profpercent20Visupercent27spercent20CV/chapterspercent20inpercent20Books/14/WASTE.pdf

SWITCH-Asia 2015: The SWITCH-Asia Programme. Retrieved 27.08.2015 from: http://www.switch-asia.eu/programme/

UNEP n.d.: Resource Efficient and Cleaner Production. Retrieved 27.08.2015 from: http://www.unep.fr/scp/cp/

ACIDLOOP DETAILED PROJECT BROCHURE

For further information please contact:

Dr Malini Balakrishnan
The Energy and Resources Institute (TERI)
Darbari Seth Block, IHC Complex, Lodhi Road,
New Delhi - 110 003, India

Tel.: +91 11 2468 2100
+91 11 4150 4900
Fax: +91 11 2468 2144
+91 11 2468 2145
Mail: malinib@teri.res.in
Website: http://www.teriin.org