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FINAL REPORT

Training Course on

***“Process Simulation and Optimization
for In-Plant Cleaner Production Assessment”***

*A training course on process simulation, analysis, optimization and control
within the framework of the industrial sustainable development*

*Nairobi, Kenya
3-7 September 2001*

organized by

ICS

in collaboration with the

Kenya National Cleaner Production Centre, Nairobi

and

UNIDO

ABBREVIATIONS

ICS	-	International Centre for Science and High Technology
UNIDO	-	United Nations Industrial Development Organization
KNPC	-	Kenya National Cleaner Production Centre
KIRDI	-	Kenya Industrial Research and Development Institute
NCPC	-	National Cleaner Production Centre

PREFACE

The training Course on “Process Simulation and Optimisation for In-Plant Cleaner Production Assessment”, was held at the Kenya Commercial Bank Management Centre in Nairobi Kenya on 3rd-7th Sept. 2001. The training course was delivered by the International Centre for Sciences and High Technology (ICS)-Italy. The Kenya National Cleaner Production Centre (KNCPC) provided organisational and administrative support before, during and after the training.

This training is one among several training courses that have been mounted by ICS in several countries in the world. The aim is to present the state of the art in process simulation and optimisation, as well as in control system and dynamic simulation, and of providing case studies, exercises and hands-on sessions providing locally lectures and process simulation laboratory. The training, targeting Directors and Deputy Directors of National Cleaner Production Centres in Africa, provided an opportunity for to discuss the special needs of concerns of National Cleaner Production Centres regarding the use of computer simulations for in-plant cleaner production assessment. The extremely open and frank discussion among the ICS lecturers and the participants, led to a very promising commitment that ICS shall work closely with UNIDO to make the software accessible to the Centres and that the KNCPC will continue to play a co-ordinating role between ICS-UNIDO and the National Cleaner Production Centres.

Thirteen (13) participants received the training. These include representatives from Zimbabwe, Tanzania, Kenya, Ethiopia and Mozambique (see list of participants, annex 11).

The Italian Government through UNIDO funded the training course. On behalf of the participating National Cleaner Production Centres, the KNCPC would like to thank the Government of Italy for this support. A big thanks to Mohammed Eisa for seeing the need to provide NCPCs with a tool for more accurate and less laborious in-plant cleaner production assessments. A special note of thanks to the Kenyan Government collaborators: the Ministry of Trade and Industry and in particular Eng. Masila, the Kenya Industrial Research and Development Institute (KIRDI) acting director, Dr. Patrick Muturi.

It was a pleasure to participate in the training and to gain new insights into challenges and opportunities provided by tools such as computer simulations. On behalf of the participants, I would like to thank ICS-Italy for the training and in particular, Prof. Gennaro Longo. I'm confident that by and large, application of these computer simulations will add value into in-plant cleaner production audits.

Ms. Jane Nyakang'o

Director

KNCPC

October, 2001

REPORT OF THE TRAINING

A. OPENING

1. The training course was officially opened by The Director of Industries, Eng. Masila on behalf of the Permanent Secretary, Ministry of Trade and Industry. Eng. Masila indicated the Government of Kenya's gratitude for the support from the Italian Government for this capacity-building course. Stressing the necessity to make industries in Africa more efficient, competitive and environmentally responsive, he underscored the importance of capacity building for rapid environmental audits to assist industry stay in business. A focussed effort on the development of human resources, institutional capacities and networking was critical for Africa's industries to produce more sustainably. He mentioned for instance in Kenya, where the environmental law requires industries to submit annual environmental audit reports, which now calls for a critical mass of experts that can satisfy the demand for this service. The ICS-UNIDO/KNCPC training of trainers course would therefore provide the much needed impetus to train professionals to support the industries.
2. Mrs. Marilina Armellin, First Secretary, the Italian Embassy on behalf of the Italian Ambassador, conveyed satisfaction for the training initiative. Training of trainers as this one is one of the ways of ensuring that present meets the needs of the present as well as the future generation. She stressed on the need to make development and environment mutually supportive. This calls for development of human expertise to implement development concepts such as pollution prevention and Eco-efficiency. She recognized the good role played by ICS-UNIDO which is supported by the Italian Government. She concluded by wishing the KNCPC well as it seeks to collaborate with ICS and the Government of Italy.
3. Dr. Patrick Muturi, Acting Director, Kenya Industrial Research and Development Institute (KIRDI) welcomed the participants and emphasized the synergistic relationship with the KNCPC, in addition to providing other supportive assistance. He stressed the cardinal role played by KIRDI in technology development and transfer to industry, and with its wide range of sector-specific expertise, is welcoming capacity building of its staff to provide the start of the art knowledge required by industries today.
4. After thanking all present and the KNCPC for co-organising the course, Prof. Gennaro Longo, the Area Director of Earth, Environmental and Marine Sciences and Technologies, ICS, provided an introduction of the overall goal of this 5 day training as well as a brief overview of research priorities of ICS. He explained that this is an ambitious project that has involved a selection of African National Cleaner Production Centres whose directors and deputies will be trained to be able to collect industrial data and assess industrial performance using computer simulations. This will enable the Centre staff to propose efficiency improvement measures that invariably have a positive effect on the environment. To conclude, he explained that ICS, fully financed by the Italian Government, operates within the legal framework of UNIDO.
5. Ms. Jane Nyakang'o welcomed the delegates and thanked ICS for giving the Kenya National Cleaner Production Centre an opportunity to host this training course. She explained that the KNCPC rests on many years of the Kenya Industrial Research and Development Institute (KIRDI) which is also hosting it as well as providing other support together with UNIDO. Most of the national sector experts for implementing the Centre's activities are drawn from KIRDI

whose parent Ministry is that of Trade and Industry. She was optimistic that through ICS, the computer software could be availed to the NCPCs whose budgets are extremely limited.

B. BACKGROUND

One of the primary goals of Sub-programme 2.1 of ICS-UNIDO, which specifically deals with Technologies for Sustainable Industrial Development, is the distribution of knowledge on decision support systems towards developing countries. In this area, the Sub-programme acts as a 'knowledge collection centre' to gain expertise on general issues such as process simulation, remote sensing and geographical information systems, and to acquire skills in using the relevant informatic tools which implement the general ideas. The Sub-programme also acts as a prime mover to facilitate a direct action in the field of monitoring systems, risk analysis and assessment, as well as the effective transfer of technology in response to environmental problems caused by industrial activities.

In the specific area of process simulation, analysis, optimization and control for cleaner production assessment, the topic has been presented and illustrated by specialists in a series of meetings and ad-hoc workshops. As follow-up of these activities, ICS started organizing several training courses with the aim of presenting the state of the art in process simulation and optimization, as well as in control system and dynamic simulation, and of providing case studies, exercises and hands-on sessions. The experience gained during these activities together with the suggestions received from the participants drove us to continue organizing the courses directly in the developing countries, providing locally, lectures and process simulation laboratory.

During the above mentioned activities, an issue which was highlighted as a major problem is the lack of adequately trained personnel in the technical communities and a lack of knowledge of the possibilities of process simulation and optimization in the decision making environment. In the developing countries, it is often the case that professional personnel, notwithstanding they are already thinly spread, are occasionally expected to perform functions beyond their technical remit. In recognizing the urgent need for developing human resource capabilities, ICS-UNIDO is attaching much importance to the training-of-trainers in the field of process simulation and optimization, with particular attention to the role of such topics for in-plant cleaner production assessment within the framework of sustainable industrial development.

Well-trained personnel would be an invaluable asset to environmental and planning agencies, which deal with complex environmental issues and problems as well as the protection and conservation of the environment on a daily basis. Such interdisciplinary knowledge would also bring about a better appreciation and understanding of the magnitude of the potential risks involved. The present activity is the natural consequence of this evangelization process and aimed at organising a similar Training Course in Nairobi.

C. JUSTIFICATION

In the Third Millennium, "sustainability" is increasingly becoming a key social, political, scientific and engineering issue. Indeed, there are increasing signs that sustainability will become a major new paradigm influencing the society of

tomorrow and the engineering it requires. With their knowledge of chemistry and physics, mass and energy flows, and process technology, chemical engineers are in a pre-eminent position to play a major role in implementing sustainable development. This role is wide. Traditionally it concerns the design and operation of chemical process plants. Nowadays it also concerns ethical and rational public policy involving science and technology.

The sustainable development, which can very simply be defined as a process in which one tries not to take more from nature than nature can replenish, can be obtained without sacrificing the many benefits that modern technology has brought. The only problem is that technology respects the imposed constraints. Engineers are asked to assess cleaner production by designing new processes and/or by modifying existing processes aiming at using renewable resources and producing by products that can be returned to the earth.

Decision support systems are a set of decision-making tools that are designed to help decision-makers to take appropriate steps in the development of new ideas and new concepts. A complete decision support system is made up by different components, the most important being the experience and the knowledge.

Process Simulation and Optimization can play dramatically an important role in the decision support system in the framework of sustainable development. This is because it allows engineers to perform process screening and a priori analysis on the feasibility of a given industrial plant as well as performing simulation of performances of waste water treatment and air pollution control. Integration of three fundamental topics (i) steady state process simulation, (ii) environmental simulation and (iii) process control can give, in the framework of the sustainable development theory, a solution for a decision making system in developed and developing countries.

For these reasons, there exists the urgent need to transfer consciousness and familiarity with information tools and techniques implementing the three general topics mentioned above. In this respect, ICS-UNIDO organized the Training Course, covering various aspects of process simulation, analysis, optimization and control.

D. OBJECTIVES

- To set-up a training course considering process simulation for in-plant cleaner production assessment within the framework of sustainable industrial development;
- To present the necessary background and basic principles necessary to understand and use the informatics tools implementing process simulations, process control and optimization techniques;
- To describe and teach 'how to use' specific programs by means of demo and 'hands-on' sessions;
- To explain how to tackle a simulation problem by showing the sequential steps to be considered in the development of a simulation and optimization strategy;
- To allow participants to gain perspective and insight into the potential applications of simulation and optimization techniques, as well as experience in the use of specific computer tools that are currently available.

E. OUTPUTS

- Training material in the form of Power Point Slides to be used as rough material for training modules and to be distributed 'as is' to the participants.
- A set of examples of application of the topic discussed in the course to be distributed to the participants.

F. STRUCTURE OF THE COURSE

The Training Course was held at the Kenya Commercial Bank Management Centre in Nairobi. It was organised such that morning sessions were dedicated to theoretical and basic subjects presented as formal lectures. Each afternoon (excluding the first day of the course), an electronic workshop session was held in which participants practised on fundamental techniques for solving on-the-job problems. Some of the afternoon sessions were devoted to working in small groups on the solution of case study problems using the computing facilities. The local organisers provided a suitable room, as well as 10 networked personal computers, printer, projector and other equipment for the practical part of the Training Course. All the activities were organised under the responsibility of the Area Director of the Area of Earth, Environmental and Marine Sciences and Technologies, Mr. G. Longo and the TC was carried out according to the attached programme (Annex 1).

G. RESULTS

- Mailing list of participants to facilitate contacts among them.
- Training material modules (power point slides) and a set of examples of the application of process simulation distributed to participants.
- Ftp site created for training course material.
- Training course structure on process simulation and optimization for in-plant cleaner production assessment.
- Questionnaire prepared and distributed in order to evaluate the importance of the process simulation content of the training course.

H. CONCLUSIONS AND RECOMMENDATIONS

- The training course was directed to technologists, planners and decision-makers of the national cleaner production centres in Sub Saharan Africa working in close contact with industry, particularly engineers, scientists and managers interested in the state-of-the-art applications of computer-based techniques for modelling chemical process. The pre-requisites included a working knowledge of chemical engineering and/or experience in the process industry and a familiarity with the use of computers to solve engineering problems.
- The final selection was made under the responsibility of NCPC representative, and in accordance with the objectives of the training course and the profile of the candidates. Thirteen participants from Ethiopia, Mozambique, Tanzania, Zimbabwe and Kenya attended the training course.

At the end of the training course, the most important messages to the participants to carry home were the following:

- Information tools may be useful in the chemical process simulation environment.

- Sustainable industrial development can be obtained by combining Process simulation, Environmental simulation and Process control.
- Process simulation is a simple tool to be used by trained people with engineering knowledge.
- Process simulation is a tool that does not interpret results: the presence of a trained engineer is essential.
- It is possible and desirable to apply process simulation in the entire life cycle of the plant.
- As a general consideration, the hands-on part was found by all the participants the most useful. The majority of the participants found the course very interesting and the topics well explained. The majority of the participants are willing to use the material and the knowledge distributed during the training course for organizing regional and local activities on process simulation. This result is of great importance for the mission of ICS and for the spreading of knowledge on process simulation and sustainable development.
- This training course must be considered the beginning of a wider project that will involve the participants in carrying out their own process simulation project. In the one week the necessary basis for the understanding was done. The next steps will be the selection and acquisition of the software, the selection of the case study and its implementation. Most participants were very much concerned about the availability of the software in due time.

I. IMMEDIATE FOLLOW-UP

- Setting up of a Web site at ICS containing all the training course material.
- Setting up of a mailing list of the participants of the training course to facilitate contacts among them.
- Setting up an e-mail address specific for the contacts with the participants.
- Help in the selection of the software by contacting the software vendors and determining the best solution for the NCPC.
- increase the application and examples.

ANNEX 1 : PROGRAMME

□ Monday, 3 September 2001

Morning

08:30 - 09:00 Registration

09:00 - 10:00 Opening Session

- Ms. Jane Nyakang'o, Director KNCPC
- Mr. G. Mariki, UNIDO Country Director
- Mr. G. Longo, Director Area of Earth, Environmental and Marine Sciences and Technologies, ICS-UNIDO
- Mrs. Marilina Arnellin, First Secretary of the Italian Embassy
- Mr. P. Muturi, Ag. Director KIRDI
- Mr. M. Chemengich, PS. Industry

10:00 - 10:20 Tea break

10:20 - 10:40 Presentation of ICS activities, Mr. G. Longo, ICS-UNIDO

10:40 - 11:10 Presentation and scope of the Training course, Mr. M. Fermeglia, ICS-UNIDO

11:10 - 11:25 Short presentation of the participants

11:25 - 11:30 Information on local arrangements

11:30 - 13:00 Sustainable industrial development in chemical productions, Mr. A. Bertucco, University of Padua, Italy

13:00 - 14:30 Lunch break

Afternoon Session

14:30 - 16:00 Process Simulation fundamentals and techniques (part 1), Mr. M. Fermeglia

16:00 - 16:30 Coffee break

16:30 - 18:00 Process Simulation fundamentals and techniques (part 2), Mr. M. Fermeglia

□ Tuesday, 4 September 2001

Morning Session

09:00 - 10:30 Steady State Process Simulation: user interface and philosophy, Mr. M. Fermeglia

10:30 - 11:00 Presentation of the User interface of different commercial products, Mr. A. Bertucco, Mr. M. Fermeglia, Mr. G. Longo

11:00 - 11:30 Coffee break

11:30 - 13:00 Data banks, physical property calculation, thermodynamic, phase equilibria models and single stage operations, Mr. M. Fermeglia

13:00 - 14:30 Lunch break

Afternoon Session

14:30 - 16:00 Hands-on: Steady State Process simulation user interface, thermodynamics and single stage unit operations, Mr. A. Bertucco, Mr. M. Fermeglia, Mr. G. Longo

16:00 - 16:15 Coffee break

16:15 - 17:30 Hands-on (continuation)

□ **Wednesday, 5 September 2001**

Morning Session

09:00 - 10:45 Industrial applications of process simulation: counter-current separation units (distillation, absorption, stripping) with examples and case studies, Mr. A. Bertucco

10:45 - 11:15 Coffee break

11:15 - 13:00 Complex separation units: conventional and supercritical fluid extraction with examples and case studies, Mr. A. Bertucco

13:00 - 14:30 Lunch break

Afternoon Session

14:30 - 16:00 Hands-on: industrial applications, Mr. A. Bertucco, Mr. M. Fermeglia, Mr. G. Longo

16:00 - 16:15 Coffee break

16:15 - 17:30 Hands-on (continuation)

□ **Thursday, 6 September 2001**

Morning Session

09:00 - 10:45 Chemical Reaction simulation and modelling with examples, Mr. M. Fermeglia

10:45 - 11:15 Coffee break

11:15 - 13:00 Batch Distillation: theory, practice and examples, Mr. A. Bertucco, Mr. M. Fermeglia

13:00 - 14:30 Lunch break

Afternoon Session

14:30 - 16:00 Industrial case studies, Mr. A. Bertucco, M. Fermeglia, Mr. G. Longo
Environmental simulation;
LPG Plant; Chemical Reactions; Ethylene production; Demethanizer;
Phosphoric acid concentration process; Propylene oxide production in reactive distillation column; Feed change analysis in oil refinery plants;
Off-gas packed column reactive absorber.

16:00 - 16:15 Coffee break

16:15 - 17:30 Industrial case studies (continuation)

Friday, 7 September 2001

Morning Session

09.00 – 10.30 Fundamentals of Process Dynamics and Control: Part I, Mr. A. Bertucco

10.30 – 11.00 Coffee break

11.00 – 12.30 Fundamentals of Process Dynamics and Control: Part II, Mr. A. Bertucco

12.30 – 13.00 Introduction to the hands-on session, Mr. A. Bertucco

13.00 – 14.30 Lunch break

Afternoon Session

14.30 – 16.00 Hands-on: fundamentals of process dynamics and control, Mr. A. Bertucco, Mr. M. Fermeglia

16.00 – 16.15 Coffee break

16.15 – 17.00 Case study on Dynamic simulation, Mr. A. Bertucco, Mr. M. Fermeglia

17.00 – 17.45 Questions and Answers and Discussion

17.45 – 18.00 Closure, Mr. G. Longo

ANNEX 11: LIST OF PARTICIPANTS

No.	Name Of Participant	Physical & Mailing Address	Tel/Fax No.	E-Mail No.
1.	Ms. Jane Nyakang'o	Director Kenya National Cleaner Production Centre Kapiti Road, Off Mombasa Road, KIRDI-South-C P.O. Box 1360, 00200 – City Square, Nairobi, Kenya.	Tel: 254-2-604870/1 Fax: 254-2-604871	Office: knpc@africaonline.co.ke Personal: jamenyakango@hotmail.com
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7.	Alemu Bezabih	P.O. Box 3762, Addis Ababa Ethiopia	Tel: 251-1-620490 Fax: 251-1-620678	ecpc@mail.telecom.net.et
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9.	Mr. Lewin Mombemuriwo	Room No.1 – Block 4 Makombe Building Complex CORNER/H. CHITEPO/Harare St. P.O. Box 1635 BORROWDALE, Harare – ZIMBABWE	Tel: 263-4-705671 or 263-4-861762	cpczim@ecoweb.co.zw

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