CHEMICAL ENGINEERING TRANSACTIONS
VOL. 26, 2012
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at: www.aidic.it/cet
Guest Editors: Valerio Cozzani, Eddy De Rademaeker

ISBN 978-88-95608-17-4; **ISSN** 1974-9791
DOI: 10.3303/CET1226075

Program to Avoid Product Leakage at Source, Fertilizer Case

Salvador Ávila*, Ricardo A. Kalid, Asher Kiperstok, Vinicius S. Carvalho

[a]Universidade Federal da Bahia - UFBA, Tecnologias Limpas (TECLIM) - Brazil
avilasalva@gmail.com

The ultimate goal of implementing a program to control the effluent is to promote the reduction of contaminants and the volumetric flow rate / mass loss of the routine operation in the process. In routine management, and in particular the routine's control of effluents, it seeks to establish general guidelines for the behavior of the shift, set goals regarding environmental aspects, and written procedures that enable standard actions. The Contamination Source Control Program is in a management instrument that reduces the generation of waste, reduces the water requirement of the plant by reducing the use of the watershed basins in the region. This work by reducing the generation of waste is part of efforts to reduce future water supply due to climate change. In application of the chemical industry, the control program at the source is composed of concepts on environmental impacts, application tools such as auditing and management of deviations from the routine, discussion on the overview of climate change and reduction of water supply, discussion about the contamination's source, losses of materials, and equipment involved. Also are discussed the control plan at the source with the goals, behaviors and tools; description of mapping tools, tracking indexes, deviation analysis, environmental education, and ways to keep the standard of effluent. The practicality of this program is demonstrated in one case applied to the Fertilizer Industry.

1. Introduction

The local and federal legislation mobilized the industry around programs to control the wastewater at the source. A program about wastewater treatment was launched by a wastewater treatment company (Pereira and Neiva, 1997), directed to operators, supervisors and process engineers. The intention was to sensitize the workers about the efficiency in the pre-treatment prior to release and include operational procedures to prevent improper disposal of substances in the liquid effluent. Note that it is still considered as end of pipe activity, as it focuses on pre-treatment and not in industrial processes.
The methods of pollution control have evolved to prioritize actions within the production processes (Kiperstok et Al, 2003). The cleaner technologies and production practices reduces the emissions of processes and are linked to contamination reduction at the source in the matrices of the processes.
The industries have been investing in environmental programs (Constanzi, 1998) that involve the use of industrial process wastes with processes lines to increase the production and control the efficiency of the waste treatment. These efforts to reuse aren't applied to industries that use large quantity of water, like the paper, food, metal and chemical industries. It is necessary to focus on programs that would reduce the consumption and the closure of the water cycles in the industrial process.
To reduce the pollutant's quantity generated are used the following measures: operate the equipment at the range of normal capacity; operate and maintain rightly the productive equipment; store rightly the fragmented materials (avoid wind disturbance); project the buildings to enable the cleaning of the area;

Please cite this article as: Avila Filho S.S., Kalid R.R.A., Kiperstok A.A. and Carvalho V.V.S., 2012, Program to avoid product leakage at source, fertilizer case, Chemical Engineering Transactions, 26, 447-452 DOI: 10.3303/CET1226075

utilization of processes, equipment and operation with lower pollution potential; utilization of row material and reagents with lower pollution potential; and the utilization of lower pollution potential fuels.
The generation of industrial liquid effluents is a complex problem (Oliveira and Daniel, 1998). It is known that the waste treatment only transfers the waste from one environment to another or from a place to another, being insufficient to resolve related problems. The Chemical industry operations don't apply appropriate tools or operational standards accordingly to the environmental area.
The investigation about the facts and data (Ávila, 2004) in the industry is important to elaborate procedures that intend to reduce the pollution loads (Giordano, 2004). It must be verified the possibility of these losses being avoided before the monitoring. It is important to analyze the tanks, pipes, and floor cleaning process due to the respective pollution loads, avoiding the solubilization and/or drag of the solid material. The productive process stops must be avoided due to the discard of the products. The leakages in bombs or pipes also contribute to the waste generation.
Ávila and Santos (1999) elaborated a method to identify impacting routines in chemical industry based in a poll about operators in different technologies: polymer, petrochemical, cellulose, and chemical. The most impacting routines were the leakages from flanges' pipelines, bombs, valves, waste management and holes in heat exchangers. Furthermore, Ávila (2004) discuss methods to minimize the waste generation at its source using data from the routine, elaborating hypothesis about failure anatomy and validating the hypothesis basing on tests on the field. Knowing about the importance of the operator's functions, Ávila (2010) investigated about the origin of failure in industry, introducing aspects of the task planning and analysis about human factors.

2. Methodology

The operation and productions teams, normally don't have conceptual base enough to execute the control at the source, and don't manage to use the control tools (PCF). Therefore concepts about the chemical process products management and handling practices are proposed.
The Contaminant Source Control Program (Figure 1) involves the presentation of concepts and description of tools that are going to be used in the routine: the mapping of liquid wastes, the water balance, the analysis of environmental deviation, the indexes analysis, the mapping of material losses, the analysis of the shift aspects, the task analysis, and the educational programs. The practical tools valuate the contaminants and the water balance and the management tools interpret the anomalies and deviation that are being present in the production's routine. The main interest is to develop a group of technicians that are able to control the process losses (Ávila, 2010). The practical tools' applications are attached to the Contaminant Source Control Program, and will help the operation team training.
Adjust of operational procedures depends of certain premises or restrictions that orients about controls and competencies to the execution of the control at the source. These premises are important information to the knowledge of the production, essential to maintain the program working. The inclusion of practical cases to the program helps in the learning of the concepts, the handling of the tools and the planning of its standards. The planning, management and execution of the method are being presented in the program in procedures form, in which are discussed the heuristics of the decisions.

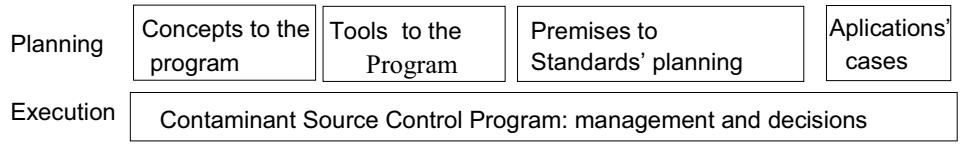

Figure 1: Planning and execution of the Contaminant Source Control Program

2.1 Conceptual basis

The material and energy losses are prohibitive when are being considered the new challenges of sustainability in chemical industry. A lot of losses could be avoided when it is understood the routine actions and the technological and management limitations in the company, avoiding the overload in the

staff and the equipment. In spite of the major part of old chemical plant operators already have the knowledge about the processes, they still don't have the idea of the process losses impacts to the equipment and different products. Thus, analyzing the environmental aspects and impacts involved in the operations is important to know about the control of the losses (Freitas, 2001). The operation should know that environmental auditing can be done in three levels, involving the management system (ISO14000), analyzing the major anomalies (incidents and accidents) and analyzing the deviations (base of the pyramid of the accident), as shown in Figure 2 . To understand the performance at the source, it should be able to explain what a contaminant is in liquid effluent and gaseous emission, and the function of a transport fluid contamination at source (Ávila, 2004). Sources of contaminants are all equipment static or dynamic or civil structure that contains, in its interior, material that may cause environmental impact.

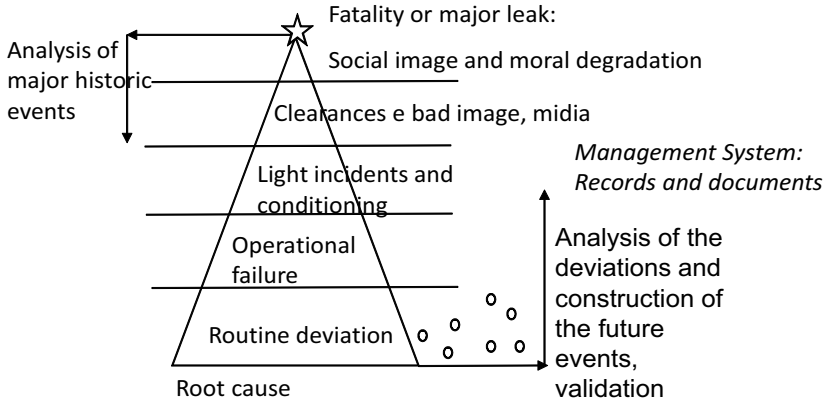

Figure 2: Integrated management, Incident (anomaly) e deviation.

The output of this material may be pure (solid of a conveyor belt) or dragged by the fluid transport (particulate air dryer tower). Some principles of cleaner production are essential to discern when there is environmental impact, for the operation of the factory can get used to low standards and must "recalibrate" their sense of environmental standards. The environmental audit accompanied by officials of the administrative department has the function of reducing these "vices", basing in the employee learning.

The Contaminant Source Control Program, when operating, intend to: (1) establish guidelines to operate the plants, avoiding the generation of effluents, respecting the quality standards maintained for the main contaminants of liquids, gaseous and solids effluents; (2) reduce contaminants and volumetric flow in systems of organic and inorganic effluent, (3) reducing the water requirement in industrial activities, reducing the use of water catchment and helping the objectives of the Water Master Plan.

2.2 Tools to help in decision

The tools to aid in the decision during the loss control process can be managerial, technical, internally standardized (enterprise tools), or developed by the academy. The group of clean technologies, TECLIM, developed management tools and techniques that can be used to keep control at the source (Kiperstok et Al, 1998; Giodano, 2004). Among these: (a) water balance, (b) ideas database on cultural, environmental and economic aspects, (c) Geographic Information System (GIS), (d) environmental variance analysis.

Other tools of the program are: (e) mapping of organic effluents for research on the source, (f) analysis of standards to control pollution at source and the water balance, (g) task analysis and the equipment that impact on the effluent, (h) analysis of events in shift to control the effluent, (i) balance of material losses, (j) education and training programs including the generation of technical bulletins. In terms of enterprise tools are: (k) the analysis of anomalies or (incidents), (l) a compliance audit of the

management system to ISO14000, (m) the analysis of deviations in the issuance of work permits, (n) procedure for the change management process and the operation of the industry.

Table 1: Applied Tools at Contamination Source Control Program

	Tools	Aims	Techn.	Manager	Enterp.	Academy
A	Water Balance	Sources, consumptions/losses A				
B	Idea Database	Idea organization / classification				
C	Geographic Information Sist.	Equipment location to design				
D	Environmental Deviation A.	Deviation causality Assessment				
E	Wastewater mapping	Investigate origin of contamination				
F	Patterns Assess	Investigate water/wastewater ind				
G	Analyses: task, equipment	Verify logic and task write				
H	Analyses: Shift events	Investigate abnormal occurrences				
I	Material Balance Losses	Investigate sources and quantities				
J	Training/ Educa	Education Program and training				
K	Anomalies Ass.	Investigate operational incidents				
L	Management System Audit	Investigate and abnormalities treatment.				
M	Work Permit Assessment	Investigate work permission				
N	Change Management	Change Assessment and impacts				

2.3 Assumptions for Planning

The Contamination Source Control Program must be constantly revised due to changes required by legislation, changes that occur in processes, degradation of equipment materials, and differences in quality of raw materials and supplies. The Program should contain restrictions of contaminating materials to equipment, processes / operations of reaction or separation, security controls and process and procedures.

The management of water supply compared with demand management and taking into account the constraints of legislation indicates adjustments for environmental sustainability (master plan). These adjustments may recommend an increase in the supply or reducing demand for water for industrial processes. The urgency of supply constraints for the future will define the urgency of reducing the demand for water. The non-contamination of effluent allows available water of average quality, which can be reused internally in the factory, reducing the demand for water. The effluent control is done from the statistical and volumetric flow of contaminants. The study of the limitations of equipment's technology and the procedures is important to identify the possibilities for changing the standards for effluent control.

Systems and/ or specific equipment may impact the generation of waste (volume or contamination): (1) raw water intake, (2) reuse of drainage of the cooling towers, (3) oil and water separator, (4) stability of vessels buried concrete, (5) inventory transfer area for the emergency pool, (6) current supply equipment for end of pipe, (7) stability in compressors and pumps and impact in the effluent, (8) leakage and emissions fugitive in pumps, (9) treatment of the product; (10) stop plant and inventory; (11) capture and effluent treatment.

A great need for harmony between policy and practice is demanded to avoid organizational mistakes (Ávila, 2010). Thus, management decisions must be consistent with the organizational policies, and they harmonized with actions at the operational level. The main reasons for not correctly identifying the dangers are: the lack of perception of deviations from routine that build future failures; the lack of communication and team cooperation; skills badly formulated for major risks; and the misalignment of

the middle management and supervision. To analyze the effectiveness of program targets are established for reducing: wastewater flow, raw water capture, water loss, loss of products, oil in the effluent. It also aims to increase reuse in water capture and concentration cycle of cooling towers, boilers.

2.4 Cases: (1) Environmental deviations Analysis, (2) Effluent Standards, (3) Mapping of Waste, (4) educational program.

The case studies help in the application of tools to control contamination of the effluent at the source. (1) In the analysis of deviations from environmental contamination with oil from industry, barriers are proposed: the use of equipment to collect the oil and maintenance work focused on reliability. (2) The statistical studies of the patterns in the effluent, (ammonia and flow) variables showed that the reduction of water consumption should be done after reducing the contamination of effluents, (3) In the case of mapping analysis of the effluent is made loads of contaminants and volumetric flow in the sources of process. Through this mapping became possible to focus the activities around the synthesis of urea stops. (4) Educational programs serve to break improper behavior (addiction) in sending contaminants into the emergency pool.

2.5 Management and decisions of Contamination Source Control Program

The Program Manager follows script of application in accordance with the steps: (1) dynamic knowledge, (2) Control and analysis of the routine, (3) Investigation of the root cause or its direction (prepare causal events and confer with balances water, wastewater and research mapping the turn of events), (4) Process losses and tasks (analyze the losses in equipment during the performance of tasks and check the balance of material losses), (5) New standards and safeguards (suggesting modifications and new standards to block a flaw that causes losses to the environment, manage these changes, if any water reuse, take care about the oscillations of quality), (6) Adjustment of behavior through educational processes, (7) Adjustment of concepts through training in shift.

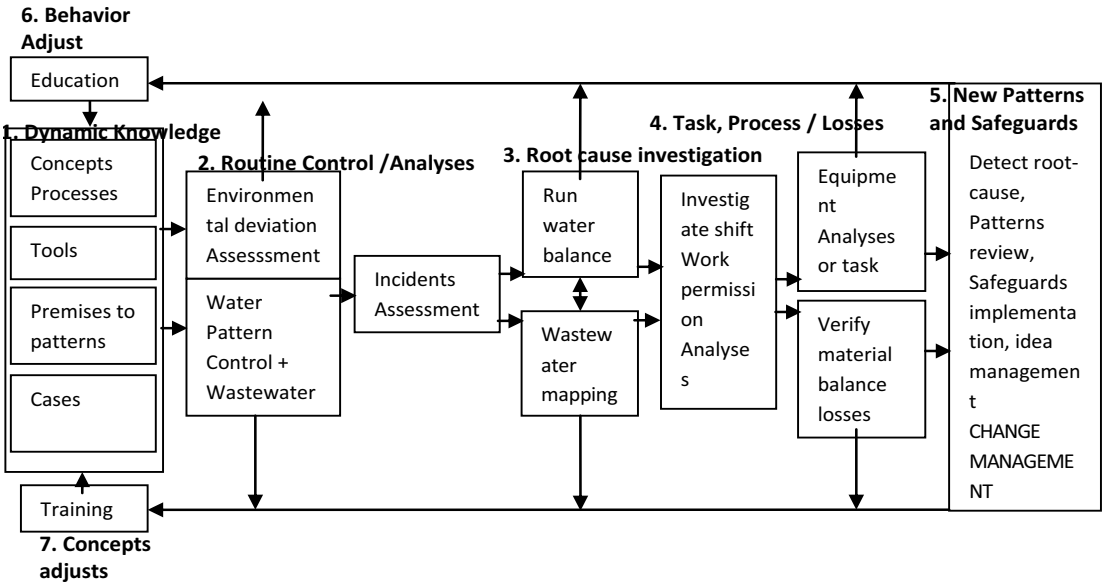

Figure 3: Management of Contamination Source Control Program

3. Case of Chemical Industry

The work of control at source is being applied in the fertilizer industry, where urea production is the result of from ammonia synthesis and urea synthesis. The greatest risks are material losses to the atmosphere (ammonia), losses to wastewater (ammonia and urea), and losses of solids (urea) that can

be washed with rain and then go to organic wastewater system. The process has low availability with many conflicts between policies and practices, leading to low effectiveness of the standards. The negative impact of losses affects sustainability and corporate image.

3.1 Application and Schedule

A manual for implementation of the source control has been prepared, indicating concepts about the source, tools, techniques, assumptions, and practical cases. The perception of deviations is done through the event registration and in particular the study of oils at compressors and machines. The tools used were water balance (detecting large water losses), ideas database (encouraging the suggestion of changes), analysis of the work permit (major provocateur of environmental impacts by drainage, vent, or leakage), and anomalies report with high losses causing loss of earnings. The construction of concepts, assumptions and discussion of the tools is deployed in six months. To the tests of the specific tools of the program takes six months.

4. Results discussion

The reduction of 15 % on volumetric flow and 30 % on contaminants charges resulted in an annual savings of one million dollars. These results were achieved using the following techniques of the program: analysis of the effluent standards, effluent mapping, analysis of anomalies, assessment of environmental deviations, shift training, educational program to prevent impacts on emergency pool, analysis of ideas and new projects. Despite the good economic results of this program, the process was with high discontinuity, causing loss of confidence, low motivation, and reduced gains achievable.

5. Conclusion

Joining techniques and tools developed in academia and industry becomes possible to apply a sustainable and economical tool that reduces water consumption and waste components of the process, from changes in the behavior of the operating staff, equipment and procedures for plant operation. Its efficiency is applied to cases in demonstration plant fertilizer, but the Source Contamination Control Program adapts to all types of industries and production processes.

References

Ávila S., Santos L., 1998. Cleaning procedures in industry. Course work (In Portugese). Teclim, Federal University of Bahia, Salvador, Brasil.

Ávila S., 2004. Methodology for minimizing waste at source from the investigation of operational anomalies: the case of the chemical industry (In Portugese). MSc Thesis, Teclim, Federal University of Bahia, Salvador, Brasil.

Ávila S., 2010. Abnormalities in the etiology of Operating Industry (In Portugese). PhD Thesis - Escola de Química, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil.

Constanzi R.N., 1998. Economics of water reuse in processes (In Portugese). ENEGEP. São Paulo. Brasil.

Freitas F.A., 2001. Environmental management through control at the source (In Portugese). Camaçari. Brasil.

Giordano G., 2004. Treatment and control of industrial effluents (In Portugese), Brasil.

Kiperstok A., Silva M, Kalid R, Sales E.A., Pacheco J.G., Oliveira S.C, Perazzo C., Fontana D., 2003. Minimization of water use in the industry through a partnership between universities and companies: the Braskem-Water Project (In Portugese). Data Analysis and Bahia, Salvador, Brasil.

Pereira F.A., Neiva M.R., 1997. Cleaning Programs: a control strategy at the source (In Portugese), Brasil.

Polonotícias, 2006. Monthly report of the companies in the Industrial Hub of Camaçari (In Portugese), n° 68. Camaçari. Brasil.