SYSTEMS & MANAGEMENT
Electronic magazine

METHODOLOGY FOR INTEGRATED COMMISSIONING PROCESS IN INDUSTRIAL UNITS

Gloria Maria Alves Ney[1], Márcio Zamboti Fortes[2]

1 Fluminense Federal University
2 University of São Paulo

ABSTRACT

Gasification is a system widely used by industry, and its commissioning should be evaluated with caution. A well-executed commissioning is fundamental for reducing labor cost and time, for predicting possible problems during the starting process and for the initial adjustments of the industrial systems. In this work, two commissioning processes were analyzed and, from them, a simplified macroprocess was generated with the main equipment. This was intended to better understand the gasification process and could assist in commissioning planning.

Keywords: Gasification, Commissioning, Planning, Macroprocessing.

1. INTRODUCTION

The evolution of project management has been growing due to the complexity of the projects, their size, project objectives and the increasing turbulence in the environment and operations (Costa *et* Ramos, 2013).

The commissioning process is extremely important for the evaluation of the systems and equipment of an industrial unit. According to Bendiksen *et* Young (2005), commissioning was a process that was associated only with the shipbuilding industry, which during the quay test the ship's equipment was evaluated and, from that assessment, it was ensured that it was in perfect condition before departure. Performing the commissioning is beneficial as it is possible to detect non-conformities and problems in their construction and assembly. Thus, by planning the necessary actions, one can reduce maintenance costs, avoid rework and reduce the time of activities. In an initial stage, it is possible to minimize the possible failures/defects at the beginning of the operation of the system under evaluation.

Commissioning is a practice applied to different systems, and some examples reported in literature are: instrumentation systems with wireless (Costa *et al.*, 2014), refinery process with heavy oil (Kemaloglu *et al.*, 2009), wastewater treatment plants (Gikas, 2008) and systems connected in a microgrid with IEC 61850 (Ruiz -Alvarez *et al.*, 2010).

Within all systems used by the oil industry, gasification is of extreme relevance due to its diversity of use (much used for the generation of electric energy) and the generation of synthesis gas (syngas), which can also be used for generating energy, as presented by Marculescu *et al.* (2016).

The gasification process refers not only to a change of physical state, but to the chemical transformation of solid or liquid fuels into a synthesis gas, which is a mixture of combustible gases. This synthesis gas can be directly ignited for the production of energy, or it may result in the raw material of other compounds of industrial origin, such as derivatives of plastic, for example, which may also result in fuels but in another physical state of matter (Silva, 2016).

PROPPI / LATEC
DOI: 10.20985/1980-5160.2017.v12n2.1189

Electronic Journal of Management & System
Volume 12, Number 2, 2017, pp. 246-251
DOI: 10.20985/1980-5160.2017.v12n2.1189

Due to the great environmental disasters that occurred in the 1990s, organizations began to reflect on the tools used and how to use energy resources (Assis *et al.*, 2012). Thus, gasification has come to reduce the use of fossil fuels.

In order to evaluate and obtain a better understanding in terms of the process of commissioning and gasification, a generic macroprocess will be presented to facilitate understanding. The macroprocess was described by Baum (2015) as a means by which an organization brings together activities with the purpose of generating value and achieving its goals. Two examples of the use of macroprocesses as a tool to support management in other sectors are: livestock (Rosado Jr. *et* Lobato, 2009) and hotels (Silva *et al.*, 1999).

The motivation for this article is the importance of performing an integrated control on the commissioning of gasification. With this, it is intended to present a generic macroprocess with the main equipment in order to facilitate understanding and to give an overview of the methodology of the commissioning. The objective is to present a methodology that can be applied to a commissioning process in a gasification system that uses, for example, petroleum products as fuel.

Firstly, the methodology consists in verifying how the gasification system of two large gasifier manufacturers, TEXACO and E-GAS, is carried out and, based on the acquired knowledge, to generate a generic gasification model that encompasses the main equipment.

2. THEORETICAL REFERENCES

2.1 Commissioning

According to Costa *et* Ramos (2013), the current projects are quite complex and require a high diversity of skills. To deal with this, new forms of management are created. Commissioning is the process that ensures that systems and components of an installation are designed, installed, tested, operated, and maintained according to the needs and operational requirements of the facility (customer) owner. The commissioning can be applied to both new installations and existing units and systems in the process of expansion, modernization or adjustment (Brito *et al.*, 2010).

The commissioning was also defined by Verri (2013) as a set of activities aimed at the preservation and verification of the functionality of items and systems, characterized by the performance of tests, verifications, measurements, calibrations, adjustments and simulation tests to “ cold ”, that is, energized tests, but without the application of load.

In the construction period of a project, the planning must be well designed to avoid delays, costs and duration of excessive activities. The same goes for commissioning, because it is at this stage that it is checked whether the systems and equipment are operating properly. According to Vaz (2010), the sequencing and dependence of the activities within the commissioning, if accumulated, can result in delays due to the end of assembly and the elimination of pending.

According to Tanaka *et al.* (2012), many improvement projects do not achieve good results due to inadequate management, poor definition of the objective and lack of commitment of the team. Therefore, for the implementation of an improvement project, it is necessary to know the relative variables to increase efficiency. Through proper planning, you can:

(i) Ensure the delivery of the work within the expected period;

(ii) Reduce the duration of commissioning;

(iii) Reduce project and maintenance cost.

For better defining and planning activities, a commissioning team must be present since the beginning of the project. This ensures the preservation of equipment, avoiding any unforeseen event during the construction of the project. This practice is not very common, due to the costs related to the maintenance of the commissioning team from the basic design to the delivery of the system in perfect operation, and in some cases, it is maintained even in the assisted operation.

In the execution of the planning, possible constraints that will exist during the project are identified. Such constraints are known as critical path. According to Bendiksen *et* Young (2005), the critical path is the longest path within a schedule, that is, it is the path whose activities have a total float (time that does not impact the duration of the project in case an activity is delayed) equal to zero. Project resources should be targeted so that delays are avoided and a prediction of problems occurs. As a result, managers are challenged to reorganize processes, reduce costs, manage time and meet other requirements, such as environment, safety, and social responsibility (Costa *et al.*, 2013).

To succeed, the planned schedule must be followed and everyone involved must understand and work on critical path activities. Each time this schedule is reviewed, the critical path must be highlighted, and current progress must be constantly checked for possible deviations. If these occur, the reason must be verified and, if necessary, the schedule updated (Bendiksen *et* Young, 2015).

Electronic Journal of Management & System
Volume 12, Number 2, 2017, pp. 246-251
DOI: 10.20985/1980-5160.2017.v12n2.1189

To organize the commissioning within a project, a commissioning plan must be prepared and elaborated during the basic engineering period. In this plan, according to Vaz (2010), the following should be contained:

Delivery of the main equipment;

Formation of commissioning teams;

Description of the systems for commissioning;

Description of the resources to be used.

Table 1 provides summary instructions for the preparation of a commissioning plan.

2.2 Gasification

Currently, there is a concern of the companies with the environmental and social impacts. This is due to the more severe laws imposed by some governments. In this perspective, sustainability is a strategic differential for companies in search of greater efficiency and performance gains through innovation (Assis *et al.*, 2012). With the search for clean fuels and the reduction of the use of fossil fuels, gasification has received considerable attention in recent decades, according to Materazzi *et al.* (2016). Continuing with the thought of Materazzi *et al.* (2016), gasification is the conversion of a solid fuel into electricity or fuel gases (synthesis gas). Before presenting the gasification macroprocess, two examples used by the industry will be presented: the Texaco process and the E-Gas process.

2.2.1 Texaco

For this gasification process, the oil and steam are mixed in the burner. During the cooling of the synthesis gas generated by the gasifier there is the removal of impurities which are eliminated in the form of slurry. After cooling, the slurry is mixed with naphtha to remove impurities from the water, and this by-product is mixed with petroleum. The naphtha is recovered in the distillation tower and brought to the decanter. After the naphtha has been removed, the remainder is used to feed the gasifier (Higman *et* Burgt, 2011).

In Figure 1, a simplification of the Texaco process is presented.

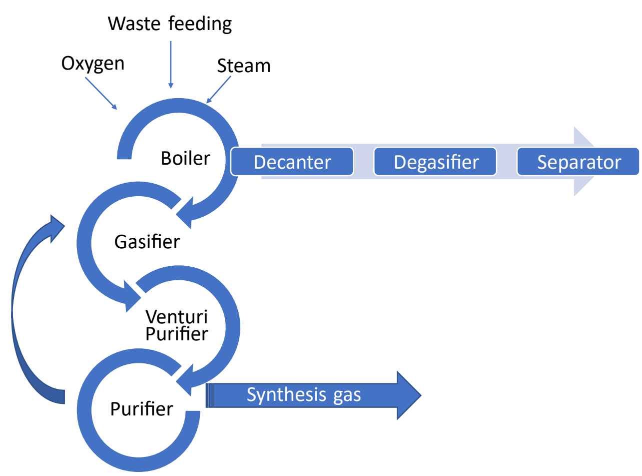

Figure 1. Texaco Gasification Process
Source: Prepared from Higman *et* Burgt (2011)

2.2.2 E-Gas

The process begins with the preparation of the fuel of the gasifier. In this process, charcoal or crushed green petroleum coke may be used and mixed with water to form slurry. Inside the gasifier, this slurry is mixed with oxygen in the first stage, resulting in the synthesis gas, which is brought to the second stage, where it is mixed with the slurry (it increases

Table 1 - Commissioning plan

Item	Document	Activities	Result	Product
1	Engineering flowchart and single-line diagram.	Perform manual demarcation and set commissioning packages.	List of packages by number and name.	Schedule of commissioning packages integrated with the enterprise
	Premise: to consider the starting of the commissioning packages at 80% of the progress bar of the system assembly or project area and ending them at the same 100% of the assembly. Objective: the planning of the commissioning must be integrated to the overall planning before the phase of construction of the enterprise.			
2	Lists of equipment, instruments, lines and cables.	Evaluate according to the defined resources.	Define the groups of the commissioning steps.	Organization chart of the stages of the commissioning process.
3	Use the composition of the products of items 01 and 02 and the labor resources for the elaboration.			Man-hour histogram of commissioning.

Source: Adapted from Vaz (2010)

Electronic Journal of Management & System
Volume 12, Number 2, 2017, pp. 246-251
DOI: 10.20985/1980-5160.2017.v12n2.1189

process efficiency). Leaving the gasifier, this gas is cooled, and the heat is reused, generating steam at high pressure. The synthesis gas is then filtered to remove the impurities. This synthesis gas, rich in hydrogen, is used to be burned in the turbine and generate electricity (CB&I, 2016).

In Figure 2, this simplified process is presented.

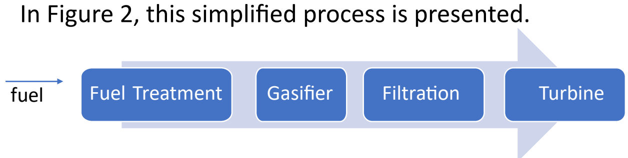

Figure 2. E-Gas Gasification process
Source: Prepared from CB&I (2016)

2.3 Macroprocess of Gasification

From the information of the studied processes, it is possible to perceive similarities between them, which allows their reduction and the presentation of the main stages of this system. Understanding this macroprocess is important for a good preparation of the commissioning, since it enables the determination with greater precision of the time and of the necessary activities, besides the knowledge of which the main equipment is.

According to Santos *et* Neto (2012), every system, when implemented, needs strategy. Actions are made to minimize risks and assist in increasing the maturity of the organization. Figure 3 presents a representation of this macroprocess under study.

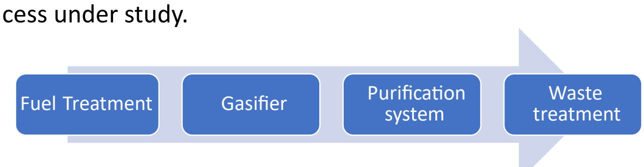

Figure 3. Macroprocess
Source: The author

3. SUMMARY OF ACTIVITIES

For the determination of the main stages of commissioning, the main activities per discipline were evaluated in each system. The waste treatment system is presented as an example of the way in which the synthesis of activities was elaborated. The disciplines analyzed were: Mechanics, Process, Electrical, Instrumentation and Control and Safety. The information of Functional Testing and Design Guides (2006) was used as reference for the summary of the activities presented below

- Mechanics:
  - All fans should have easy access for installation and maintenance;
  - Consideration must be given to the installation and operation of the speed variation gauge;
  - Check that the motors are compatible;
  - All transmission belts should be adjusted and aligned;
  - Make sure ducts have not been contaminated with water and dust during construction;
  - Check that the fan capacity conforms to the instruments used and under what conditions the tests will be performed;
  - Check alignment, fixation and identification of the components of the mechanical assemblies.
- Electrical:
  - If necessary, the motor must be grounded;
  - Backdraft dampers need to be tested for proper operation. Dampers that are not motorized shall open and close freely without binding, and motorized dampers shall be connected to the control/automation system, verifying that they are opening prior to fan operation;
  - Check phase sequence and power supply of driving equipment;
  - Simulate faults in the power system and check signals in the supervisory (for example, overload tripping, temperature rise in the windings).
- Instrumentation and Control:
  - Check whether pressure drop is triggered by the fire-fighting system and smoke damper;
  - Perform loop testing for instrumentation meshes;
  - Follow instrument verification scripts in the set-points defined in the project engineering;
  - The system must be designed to maintain constant pressure, and other instrumentation systems must be checked.

Electronic Journal of Management & System
Volume 12, Number 2, 2017, pp. 246-251
DOI: 10.20985/1980-5160.2017.v12n2.1189

- Safety:
    - Safety equipment and systems must be in good condition and reliable;
    - The designed system shall be in accordance with Occupational Safety and Health Administration (OSHA) standard/local legislation, and clean;
    - They must be installed and tested to verify proper operation of the pressure relief ports.
- Process:
    - The return, relief, and exhaust systems shall not exceed the pressure values stipulated in the design;
    - Monitor for project values the operation of major equipment, eliminating / recording anomalies and process standards outside the flow chart references of projected processes.

4. CONCLUSION

With increasingly complex projects, it became necessary to carry out better monitoring and planning. One of the steps that most needs attention is the commissioning, which, if carried out properly, can reduce costs, assist in the detection of irregularities and reduce rework. According to Bendiksen *et* Young (2015), from 80 to 90% of the risks that materialize at the commissioning stage could be predicted, avoiding the reworking. This is because most risks from a management point of view are generic.

The system highlighted in this work is gasification, which can be used in several industries for the generation of fuel gas and energy. For a better understanding of this process and to facilitate the planning of the commissioning, a macroprocess with the main equipment is proposed. From the evaluation of procedures used by the industry, the key equipment and a summary of the main activities were detected.

It is understood that the simplification of commissioning with the reduction of activities for those considered essential is a way to reduce the cost with complex worksheets, contemplating systems in which, often, there is no activity or equipment installed. That is, the planning of commissioning is elaborated considering the list of activities in which there is no function to commission in the process in application. When presented with a reduced macroprocess and disciplinary planning, focusing only on basic systems, the time and cost in this process is reduced, allowing the planner to insert specific activities of equipment/process only when there is a need to evaluate the function.

In the example in focus, it is noted that the use of a macroprocessor becomes relevant to the proper understanding. With this understanding, one can plan the commissioning of the gasification system correctly, once its main equipment is known. From this premise, it is possible to elaborate the schedule with the necessary activities and the appropriate time. Thus, with the knowledge of the macro-process of gasification, it becomes feasible to prepare the commissioning of the main equipment, facilitating its planning and focusing on the minimization of costs and activities in a first analysis.

REFERENCES

Assis, B. F. S. P. et al. (2012), "Metodologia para análise de maturidade de inovações sustentáveis", Sistemas & Gestão, Vol. 7, No.3, disponível em: http://www.revistasg.uff.br/index.php/sg/article/view/V7N3A10/V7N3A10 (Acesso em 07 de junho de 2016). doi: http://dx.doi.org/10.7177/sg.2012.V7.N3.A10

Baum, E. (2015), "Conceitos básicos de atividades, tarefas, processos e macroprocesso", disponível em: http://www.sabesim.com.br/conceitos-atividades-tarefas-processos-macroprocesso/ (Acesso em 02 de maio de 2016).

Bendiksen, T. et Young, G. (2005), Commissioning of offshore oil and gas projects: the manager's handbook, AuthorHouse, Estados Unidos.

Bendiksen, T. et Young, G. (2015), Commissioningof offshore oil and gas projects: the manager's handbook, 2 ed., AuthorHouse, Estados Unidos.

Brito, A. S., Ribeiro, H., Matos, L. M. (2010), Comissionamento em sistemas de tubulações de utilidades, Monografia apresentada como pré-requisito para a conclusão do curso de Construção e Montagem de Tubulações Industriais – Ênfase em Petróleo e Gás, Instituto SENAI de Educação Superior, Rio de Janeiro, RJ.

CB&I (2016), "E-Gas process overview", disponível em: http://www.cbi.com/technologies/e-gas-process-overview (Acesso em 05 de abril de 2016).

Costa, C.E.S. et al. (2014), "Industrial Wireless Instrumentation and the Current Commissioning Model" IFAC Proceedings Volumes, Vol.47 No.3, pp.2617-2621. doi: 10.3182/20140824-6-ZA-1003.02035.

Costa, S. R. R. et Ramos, A. F. B. (2013), "Modelo de maturidade em gerenciamento de projeto: em estudo de caso aplicado a projetos de petróleo e energia", Sistemas & Gestão, Vol. 8 No. 3, disponível em: http://www.revistasg.uff.br/index.php/sg/article/view/V8N3A2/V8N3A2 (Acesso em 07 de Junho de 2016). DOI: http://dx.doi.org/10.7177/sg.2013.V8.N3.A2.

Electronic Journal of Management & System
Volume 12, Number 2, 2017, pp. 246-251
DOI: 10.20985/1980-5160.2017.v12n2.1189

Functional Testing and Design Guides (2006), "Return, Relief, and Exhaust: Functional Testing Checklist Tool", disponível em: http://www.ftguide.org/ftct/ahu-rtnrelexh.htm (Acesso em 28 de março de 2016).

Gikas, P. (2008), "Comissioning of the Gigantic Anaerobic Sludge Digesters at the Wastewater Treatment Plant of Athens", Enviromental Technology, Vol.29, No.2, pp.131-139. doi: 10.1080/09593330802028469.

Higman, C. et Burgt, M. V. D. (2011), Gasification, Gulf Professional Publishing, Estados Unidos.

Kemaloglu, S. et al. (2009). "Model Predictive Control of a Crude Distillation Unit an Industrial Aplication", IFAC Proceedings Volumes, Vol.42, No.11, pp.880-885. doi:10.3182/20090712-4-TR-2008.00144.

Marculescu, C., Cenusa, V., Alexe, F. (2016), "Analysis of biomass and waste gasification lean syngases combustion for power generation using spark ignition engines", Waste Management, Vol.47, pp.133-140. doi:10.1016/j.wasman.2015.06.043.

Materazzi, M. et al. (2016), "Waste Management", Elsevier, Vol. 47, pp. 256-266.

Rosado Jr., A.G. et Lobato, J. R. P. (2009), "Application of a model of management by macroprocesses to a beef cattle enterprise: a case study", Revista Brasileira de Zootecnia, Vol.38, No.11, pp.2280-2288. doi: 10.1590/S1516-35982009001100030

Ruiz-Alvarez, A., Colet-Subirachs, A., Gomis-Bellmunt, O. et al (2010), "Design, management and comissioning of a utility connected microgrid based on IEC 61850", Proceedings of 2010 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT Europe), pp.1-7. doi: 10.1109/ISGTEUROPE.2010.5638857.

Santos, J. P. et Neto, G. C. O. (2012), "Uma contribuição para a excelência em gestão da qualidade na indústria metal mecânica: estudo de múltiplos casos e survey", Sistemas & Gestão, Vol. 7 No.3, disponível em: http://www.revistasg.uff.br/index.php/sg/article/view/V7N3A9/V7N3A9 (Acesso em 07 de Junho de 2016). DOI: http://dx.doi.org/10.7177/sg.2012.V7.N3.A9

Silva, A. L. S. (2016), "Gaseificação", disponível em: http://www.infoescola.com.br/reacoes-quimicas/gaseificacao/ (Acesso em 10 de maio de 2016).

Silva, C. F., Neres, W. A., Varvakis, G. (1999), "Busca de Melhorias em Serviços: Uma Aplicação na Indústria Hoteleira", Anais do XXIX Encontro Nacional de Engenharia de Produção, pp.1-20, em: http://www.abepro.org.br/biblioteca/ENEGEP1999_A0135.PDF. (Acesso em 12 de junho de 2016)

Tanaka, W. Y. et al. (2012), "Fatores críticos para implantação de projetos de melhoria continua Segundo líderes e construtores industriais", Sistemas & Gestão, Vol., 7 No.1, disponível em: http://www.revistasg.uff.br/index.php/sg/article/view/V7N1A7/V7N1A7 (Acesso em 07 de Junho de 2016). DOI: http://dx.doi.org/10.7177/sg.2012.V7.N1.A7

Vaz, M. A. M. (2010), Melhores práticas de comissionamento, Schoba, Salto, SP.

Verri, L. A. (2013), "Gestão de ativos: o comissionamento antecipado na construção e montagem como vetor positive na preservação da confiabilidade", Anais do XXVII Congresso da Abraman, em: http://www.verriveritatis.com.br/Toro/marco2013/ABRAMAN.pdf. (Acesso em 22 março de 2015).