REPLACEMENT OF ELECTRIC POWER BY NATURAL GAS IN THE MANUFACTURE OF RIGID PIPES

André Ferraz[1], Ivan Rocha[1], Ricardo Konishi[1], Willian Lehmkuhl[1]

[1] Companhia de Gás de Santa Catarina – SCGÁS

Keywords: Rigid Pipes; Electricity; Natural Gas

BACKGROUND

Faced with the demand for technical support identified by the Gas Company of Santa Catarina - SCGÁS - for the appropriate service to its customers the Natural Gas Technology Department (GETEC) was structured to promote solutions that bring greater feasibility of using this fuel. Among the main activities developed by the department are technical support, research and technological development, and dissemination of knowledge about the applications of natural gas. Among the lines of action adopted by SCGÁS, for the diversification of natural gas usage, is replacing the electricity in thermal processes. The electrothermal can be defined as the use of electricity to produce heat. This is a challenge that has been successful even in small applications such as textile polymerizer's kilns, paint drying kilns and even tanks for metals phosphating. This paper presents an interesting application of natural gas, as a substitute for electricity, in the manufacture of rigid tubes of epoxy resin reinforced with fiberglass and catalyzed with a curing agent based on aromatic amine. These tubes have important applications in the oil industry, and its high-resistance is obtained with the curing and post curing with special resins.

AIMS

This paper presents a study of how electric energy in a process of curing and post curing of epoxy rigid pipes can be replaced by burning natural gas. It is shown that by performing this substitution, through conversion of electric-powered appliances to natural gas, brings a reduction of almost 30% of financial economics.

METHODS

The tubes are manufactured by continuous winding process where you put the liner (pipe) in a mandrel that performs rotation movements. The continuous winding process is the most traditional and reliable method available for making cylindrical tubes and similar equipment. Widely used around the world, the process provides a high level of automation and control with high productivity and economy.

The continuous winding consists of applying the raw materials (resin + fiberglass) cast on a rotating over the tube in order to build step by step the layers forming the wall of the product. In a programmed and controlled process, each material is deposited on the mold in the amount, proportion and manner prescribed in the project in order to give the tube the physical characteristics expected. Finally this tube is then sent to aromatic amine-based curing, post-curing and then to the finish.

Through a case study was conducted an evaluation of the process and the original machinery used. Figures 1 and 2 show the curing and post-curing kilns that operated by electricity.

In Figure 1, we can observe the rising of the tube on the mandrel to the curing kiln via an overhead crane. The kilns consist of “boxes” in which longitudinal tubes are coupled to the heated curing process.

Figure 1: Electric kilns of curing and post-curing – material’s loading

With the tube already placed in the kilns, the curing process of the tube begins, which rotates while it is heated by electric resistances located in the walls of the kilns, as shown in Figure 2.

Figure 2: Electric kilns of curing and post-curing – mandrel placed

RESULTS

Based on the field data (electric power, heating efficiency, load factor, operating systems and average cost of energy), tables were prepared that briefly express the monthly electricity cost for curing and post curing. These tables are identified as Table 1 for the curing and Table 2 for kiln of post-curing.

Power Consumption Estimates (Curing Kilns)	
Electric Power [kW]	298
Heating Efficiency	0,80
Load Factor	80%
Operation Regime [hours/day]	24
Operation Regime [days/month]	26
Electricity Consumption [kWh/month]	148.512
Thermal Energy Transferred [kW]	190,40
Average Cost of Electric Energy [R$/kWh]	0,19427
Monthly Cost [R$/month]	**28.852**

Table 1: Electricity consumption of curing kiln

Power Consumption Estimates (Post-Curing Kilns)	
Electric Power [kW]	80
Heating Efficiency	0,80
Load Factor	80%
Operation Regime [hours/day]	24
Operation Regime [days/month]	26
Electricity Consumption [kWh/month]	39.936
Thermal Energy Transferred [kW]	51,20
Average Cost of Electric Energy [R$/kWh]	0,19427
Monthly Cost [R$/month]	**7.759**

Table 2: Electricity consumption of post-curing kiln

From the operational characteristics of these devices some economical calculations and simulations of technical feasibility were developed, which resulted in a conceptual design of a new kiln with equivalent production and operated with natural gas. Table 3 shows the equivalent consumption of natural gas.

Consumption Equivalent of NG (Estimated)	
Thermal Power [kcal/hour]	207.739
Heating Efficiency	0,60
Lower Heating Value (LHV) NG (Kcal/m³)	8.610
NG Consumption (m³/hour)	40
Operation Regime [hours/day]	24
Operation Regime [days/month]	26
Daily Consumption – NG [m³]	825
Consumption [m³/month]	**25.093**

Table 3: Natural gas equivalent in the kilns

Figures 3 and 4 illustrate the prototype that was developed and is already in operation. Figure 3 shows the curing and post-curing kilns already adapted to run on natural gas, without load, where the holes can be observed for the injection of hot air, allowing the tubes to be cured by heating. This hot air is produced by burning natural gas in a chamber, located at the bottom of the new designed kiln, which also serves to mix a certain amount of dilution air.

The process of making tubes follows the same principle of the equipment powered by electricity, that is, with the help of a crane. These new devices have similar "boxes" dimensions.

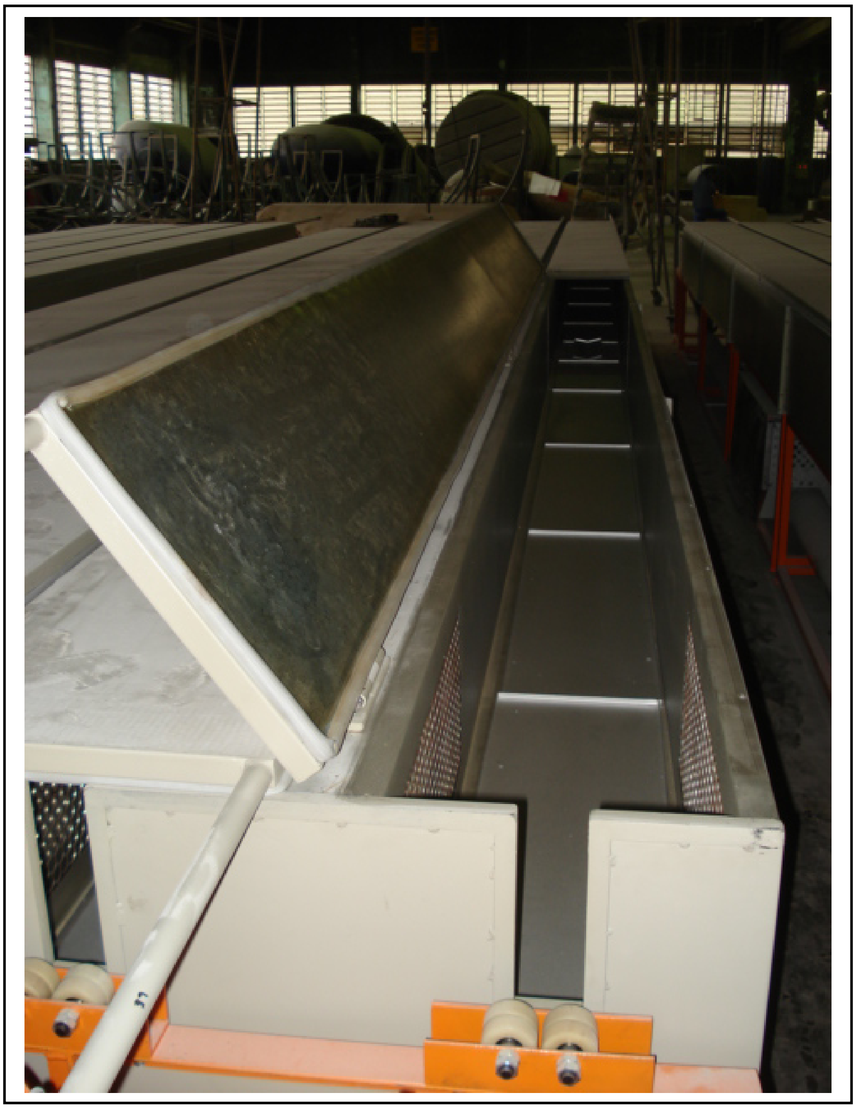

Figure 3: Curing and post-curing developed natural gas kilns - without load

Figure 4 shows in more detail the engine that keeps the mandrel turning for a specific time prior to the curing process and post-curing to take place. This time is automatically timed, from the activation of the kiln.

Flexibility and productivity were obtained by equipment replacement in the process, due to a faster start-up and achievement of operating regime. Besides the generated savings, the final product after the mandatory tests, proved to be of better quality when produced using natural gas instead of electricity.

Figure 4: Curing and post-curing developed natural gas kilns – in operation

Seeking to further enhance the relationship with industrial clients already conquered, rewarding those who are deserving of special treatment, the SCGÁS developed the Loyalty Plan, an instrument of compromise between the company and its customers. The Loyalty Plan contemplates a SCGÁS loyalty with awards for the good payers, the industrial customers with the optimized schedule of consumption and that only use natural gas in their processes of heating.

Tables 4 and 5 show the values of annual natural gas consumption and its energy operating cost of the new equipment where this study was performed. We applied the current natural gas tariff charged by SCGÁS both with and without the Loyalty Plan. At the end the highest percentage of savings obtained in this study case was 33%.

Economy	
NG Annual Consumption [m³]	301.112
Average Rate [R$/m³)	1,13045
Annual Operation Cost - NG (R$)	340.392
Annual Operation Cost - Electricity (R$)	439.327
NG Economy (R$/year]	98.935
Percentage of Saving [%]	**22,5%**

Table 4: Final Economy

Economy	
NG Annual Consumption [m³]	301.112
Average Rate – NG with LP of 5% [R$/m³)	0,97896
Annual Operation Cost - NG (R$)	294.776
Annual Operation Cost - Electricity (R$)	439.327
NG Economy (R$/year]	144.551
Percentage of Saving [%]	**33%**

Table 5: Final economy with Loyalty Plan (LP)

CONCLUSIONS

In this study we evaluated the economic feasibility for replacing electricity to natural gas to supply the curing and post-curing kilns in the manufacture of epoxy resin rigid tubes.

The company energy monthly operational cost was reduced by 33% with the adoption of the new equipment designed to use natural gas. Furthermore, the company's responsibles observed that there were improvements in operational flexibility, productivity and quality of the final product.

As a final consideration, we register the perspective of electricity costs increasing in the future and also the increased supply of natural gas from the exploration of new reserves announced in Brazil.

In terms of rational use of energy, the application of electricity to thermal processes is always discouraged when considering the entire chain of generation, transmission, distribution and final use. In this case, natural gas presents itself as a more efficient alternative, which is validated in small industrial applications as it was demonstrated in this work.

REFERENCES

1. Nunes, L. R., Rodolfo Jr, A., Ormanji, W., Hage Jr, E., Agnelli, J. A. M., Pessan, L. A. (2002). Tecnologia do PVC, 2ª edição revista e ampliada.
2. Costa, V. M., Gonçalves, R. A. B., Coelho, R. D. (2003). Processos e Fabricação de Tubos e Conexões de PVC, XXXII Congresso Brasileiro de Engenharia Agrícola.