Masters in Engineering in Industrial Process Automation

Design and control of a steam boiler of 2 B.H. based on the ASME standard codes.

Jorge Alejandro León Ruiz

Williams Ortiz Martinez

María Leticia Ramírez Castillo

Fernando González Manzanilla

IX Symposium de Posgrado

Design and control of a steam boiler of 2 B.H. based on the ASME standard codes.

Jorge Alejandro León Ruiz, Williams Ortiz Martinez, Fernando González Manzanilla, María Leticia Ramírez Castillo, Juan Antonio Arizaga Silva

Masters in Engineering in Industrial Process Automation

{Jorge.leon4409,Williams.ortiz}@uppuebla.edu.mx

Tercer Carril del Ejido Serrano S/N, San Mateo Cuanalá, Juan C. Bonilla, Puebla, México

1. Introducción

The steam boilers have accompanied the development of humanity since the seventeenth century, from the improvements made by Jammes Watt. Technology has contributed to the innovation of this type of equipment, which means that they do not lose their validity and continue to be necessary in the industry for various applications in processes (food, pharmaceutical, tectile, transport, etc.) [1]. That is why the international associations of engineers established standards of building standard codes for boilers and pressure vessels, the most widely used being the ASME code [2].

On the other hand, the efficient explotation of steam generators is imposible to achieve without the applcation of an automatic control, which increases the reliability and safety in the operation of these equipment [3]. This paper presents the design and control of a pressure vessel, used for a steam boiler of 2 B.H.

2. Objetives

2.1.General Objectives

Design and implement a vertical pirotubular steam boiler of 2 B.H.

2.2. Specific Objetives

- Develop a steam boiler using ASME standards.
- Implement a control system of steam pressure, water level and gas supply.
- Program a graphical interface for control and monitoring of boiler parameters.

3. Methodology

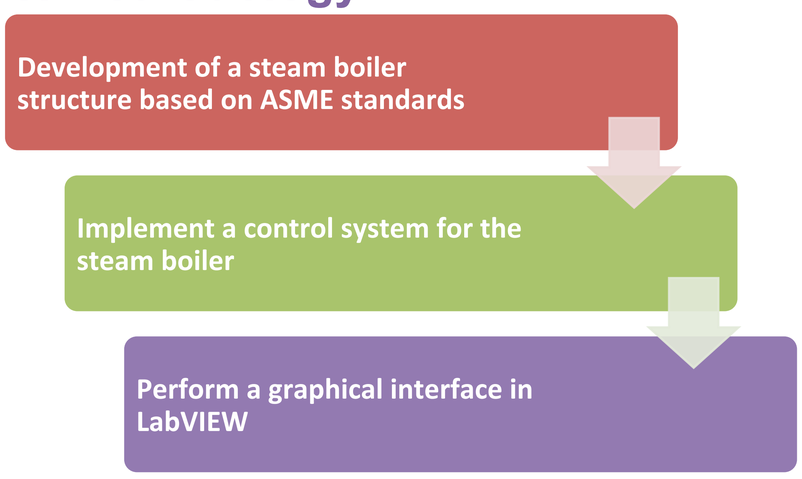

Figure 1. Development methodology.

Structure of the steam boiler.

The power of the steam boiler at 2 B.H. equals 18.6 kW [2]. Working conditions were $150\,°C$ y 5 kg/cm^2 .

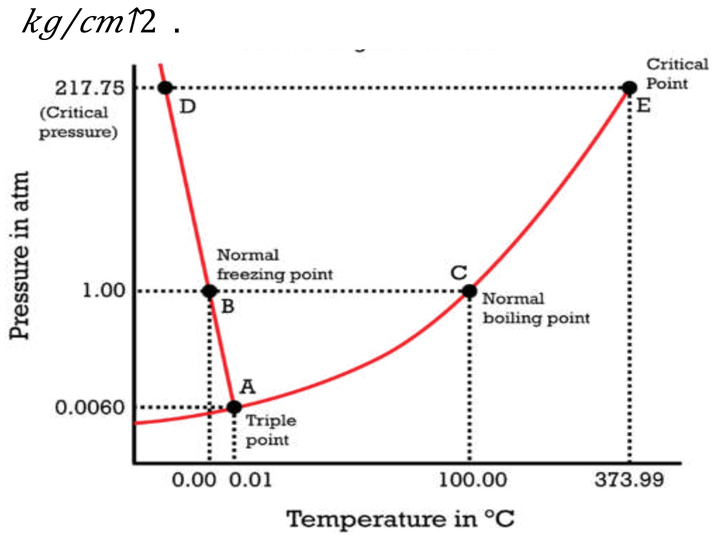

Figure 2. Phases diagram for water.

ASME standard codes.

Section I and II of the ASME standard codes were use [2]:

1. Construction methods of power boilers and high pressure (PG).
2. Boiler requirements manufactured by welding (PW).
3. Requirements for pirotubular boilers (PFT).
4. Requirements for miniature boilers (PMB).

Design in SOLIDWORKS.

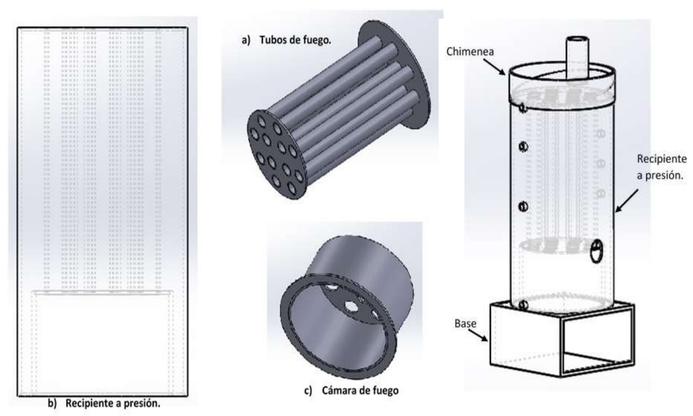

Figure 3. Steam Boiler design in CAD.

Control system

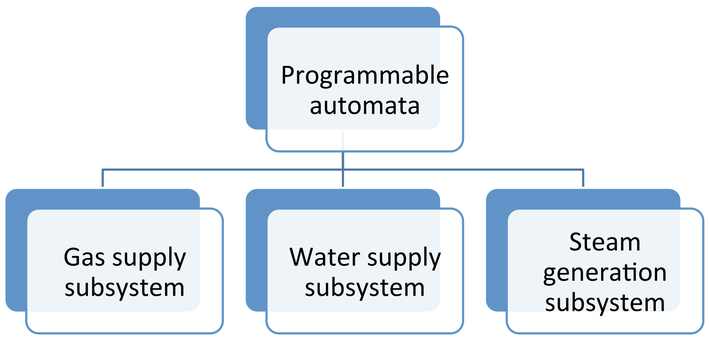

Figure 4. Block diagram of the integral automatic control system of steam generators [3].

Graphic interface in LabVIEW

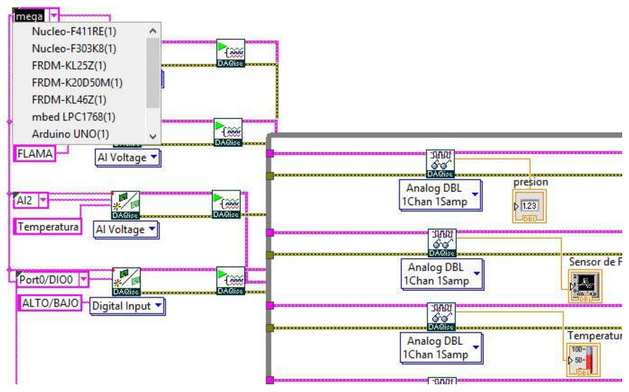

Figure 5. Block diagram programming with embedded system selected to be used.

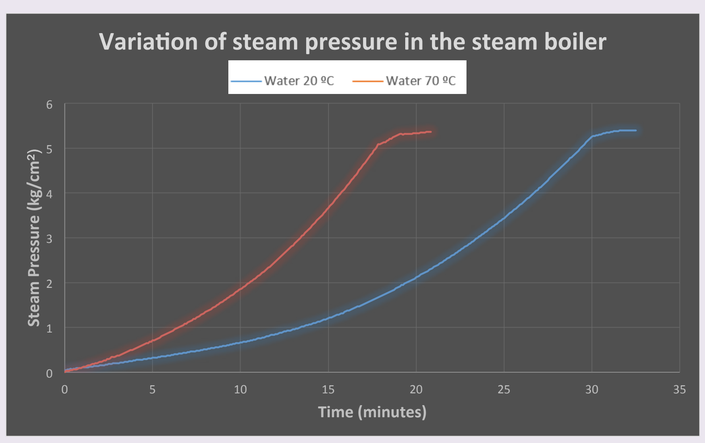

Figure 9. Control response implemented with LabVIEW y ATMEGA 25.

4. Results

As a result of the analysis, a maximum tension in the container of $160\,kg/cm^2$ was obtained, which is below the elastic limit of the material.

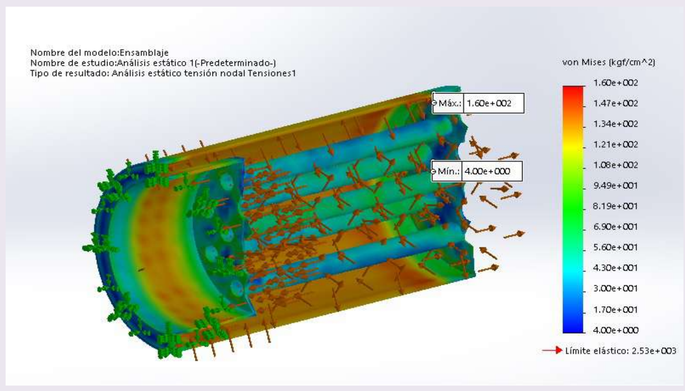

Figure 6. Stress simulation of Von Mises (Carbon Steel).

Figure 7. Structure of the steam boiler of 2 B.H.

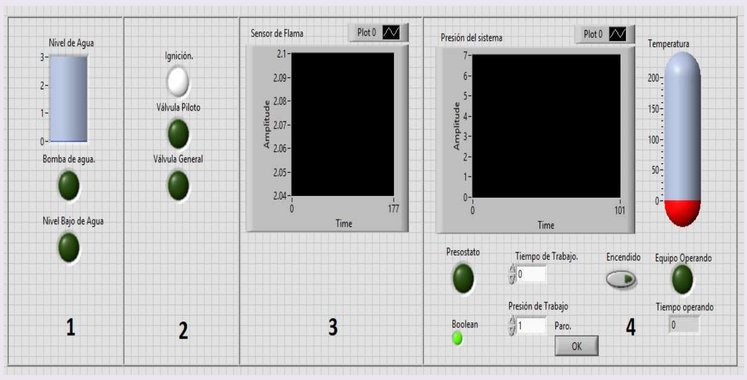

Figure 8. Graphical interface for monitoring and data acquisition in LabVIEW.

5. Conclusion

A study was made on the principle operation of fire tube boilers (pirotubular) as an object of mechanical design. For it's design and construction, ASME standards were considered. The results obtained show that the design is effective and reliable, due to the correct selection of materials and the hydrostatic tests carried out on the steam boiler. Regarding the integral automatic control, based on embedded systems, this allows to obtain an effective control of the operation and makes it possible to significantly improve the efficiency of this type of machines.

6. Acknowledgement

The authors thank the National Council of Science and Technology (CONACyT) for the Master's degree in engineering from the engineer Jorge Alejandro León Ruiz.

References

[1] J. C. Betancourt Prisco and J. E. Ospina Berrío, "Diseño y construcción de un prototipo de caldera que usa como combustible cáscara de jatropha curca," B.S. thesis, Universidad EAFIT, 2010.

[2] A.S. of Mechanical Engineers, Código ASME 2010 para calderas y Recipientes a presión.(SECCION I y II).

[3] Rivas, R., Aref, R., César, E., & Inga, J. (2000). Sistema de control automático integral de generadores de vapor pirotubulares. *Ingeniería Electrónica, Automática y Comunicaciones*, *21*(2), 10-19.

[4] R.B. Córdova Ordoñez, L. Pullaguari, and J. Israel,"Diseño y construcción de un caldero de 7.5 bhp para generación de vapor".B.S. thesis(2011).

2019