PRESSURE STABILISATION SYSTEM—THE NEED OF THE SUGAR INDUSTRY

By

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Abstract

OVERALL stabilisation of sugar factory operations is achieved with various automatic control systems for the continuous operation of the sugar plant. Because batch type pans are used for crystallisation, process steam demand always fluctuates, thus disturbing the overall process stability. This poster paper outlines a system that has been successfully implemented to control and stabilise steam pressures around the evaporator and pan stations. Pan stage steam requirement is supplied from the evaporator station by adopting extensive vapour bleeding techniques for achieving better steam economy. Hence, fluctuation of the pan steam demand is transferred to the evaporator station, thus affecting evaporator performance, with fluctuation in syrup brix and exhaust steam pressure. A pressure reducing valve and overflow surplus valves are introduced to meet the fluctuating pan demand by bleeding steam from the boiler directly with a cascading effect. Proper controls of the valves are provided to maintain the boiler steam pressure within permissible limits. The cascading effect ensures stabilised conditions of the exhaust steam and pan vapour pressures. Hence, the evaporator performance is stabilised, resulting in uniform evaporation rates and constant syrup brix. This resulted in an increase in crushing capacity of the plant. Fluctuation in boiler steam pressure due to fluctuating process demand is eliminated. Hence, performance of boiler automation is further improved. In addition to other stabilisation measures, the steam pressure stabilisation system is essential for stabilised evaporator performance. This will lead to an increase in overall plant capacity and achieve better steam economy.

Introduction

Stabilisation plays a very important role in the sugar industry towards improvement in crushing capacity and operation of the plant at its optimum efficiency. This is achieved with various control systems such as automatic cane feed control, mill automation and juice flow stabilisation etc.

Due to the non-continuous operation of batch pans used for crystallisation, the pan floor steam consumption will always be a fluctuating demand. For better steam economy, the pans are boiled from vapours bled from the evaporator set.

Thus, the fluctuation in pan steam demand is transferred to the evaporator station. Due to this phenomenon, the automation provided at the evaporator station for juice level control was not giving satisfactory results.

Hence, the Pressure Stabilisation System outlined in this paper was developed to stabilise the exhaust steam, pan vapour and live steam pressure.

Control philosophy and respective valve operation

The schematic diagram of the control philosophy of the pressure stabilisation system is shown in Figure 1.
The main elements of this system are as follows:

**Pressure reducing valves (PRVs):** Two automated pressure reducing control valves (PRV-1 and PRV-2) with both down-stream and up-stream sensors are required.

- PRV-1 supplies live steam at reduced pressure in the region of 0.6–0.7 MPag (6–7 kg/cm² gauge) for sulfur melting and for the super heated wash water system at the centrifugal station. Up-stream control senses the live steam pressure and the down-stream control senses the reduced live steam pressure. This valve is independent of the above pressure control system.

- PRV-2 is provided for supplying live steam to the exhaust steam header for process utilisation. This valve plays a very important role in this pressure stabilisation system. Up-stream control senses the live steam pressure directly on the main live steam distribution header and the down-stream control senses the pan vapour pressure.

**Overflow surplus valves (OSVs):** There are three overflow surplus valves operating on different parts of the system.

- In the exhaust line (OSV-1)—a globe type control valve, provided with up-stream pressure control. Installed in the exhaust steam line for bleeding excess exhaust steam into pan vapour line.

- In the second effect vapour line (OSV-2)—a globe type control valve, provided with up-stream pressure control. Installed in the vapour outlet line of the evaporator body bleeding to pans.

- In the pan vapour line (OSV-3)—a globe or butterfly type control valve, provided with up-stream pressure control. Installed at the furthest end of the pan vapour line.

**Relief valves (RVs)—** Dead weight type safety valves. Installed at the furthest end of pan vapour line.

**Desuperheaters (DS):** Two desuperheater systems are required to reduce the superheat on the live steam that enters the system. To de-superheat the reduced live steam from PRV-1 to saturation temperature. This is independent of the above control system. To de-superheat the exhaust steam from all sources i.e. from various prime movers and PRV-2 to saturation temperature.
Air compressor (for PRVs and OSVs)—to supply oil and moisture-free air at a delivery pressure of about 0.7 MPag (7 kg/cm² gauge) for operating the pressure reducing and overflow surplus valves.

Pressure recorders—for continuous monitoring of the performance of the system.

System operation

OSV-2
Whenever a pan starts, the steam demand at the pan station increases and hence tries to draw more vapour from the evaporators, resulting in a drop in vapour pressure of the 2nd effect. OSV-2, working on up-stream control, will start closing in order to maintain constant pressure in the 2nd effect. This will help to maintain a constant differential pressure (or differential temperature) across the 2nd effect, which means constant evaporation, constant syrup brix and minimum disturbance to the evaporator station.

PRV-2
When the vapour pressure in the pan vapour line drops too low, this valve provides a signal to PRV-2, working on down-stream control, to open to supply live steam into the exhaust line. Thus, the exhaust steam pressure is slightly boosted from its existing pressure.

At the same time the control also checks the upstream pressure. If the upstream pressure is less than the set point, the valve will not open to supply the additional requirement, even though there is a demand in pan vapour line. This is an over riding control over the down-stream side demand. This ensures that the boiler can be operated within the allowable pressure fluctuations without causing any major changes in boiler operating parameters.

OSV-1
When the live steam is bled into the exhaust line through PRV-1, the exhaust pressure tends to rise. When the exhaust steam pressure rises above the set point, OSV-1 opens and allows exhaust steam into the pan vapour line. With this flow, the exhaust steam pressure remains constant for constant evaporation in the evaporator set.

When the pan demand is met, the vapour pressure stabilises and the bleeding of live steam and exhaust steam returns to normal set point. Thus, both exhaust steam pressure and pan vapour pressure are stabilised.

OSV-3
As and when the steam demand at the pan station reduces, a case normally experienced when most pans are almost full or dropping, the pan vapour pressure rises momentarily due to excess vapour present in the line. This excess vapour should be blown off to atmosphere through OSV-3 as per the set point. This is necessary to maintain constant evaporation at evaporator bodies.

Fig. 2—Exhaust pressure chart.

PRV-1
This valve operates within the set points of down-stream and up-stream controls.

With these OSV and PRV control valves, the pressures of live steam, exhaust steam and pan vapour line are stabilised. With stabilised pressures, the working of the plant will automatically improve.
Results

Two charts recording the exhaust steam pressure on a single day before and after implementation of the Pressure Stabilisation System are shown in Figure 2. This indicates a remarkable improvement in the stabilisation of exhaust steam pressure resulting in balanced working of the plant with improved efficiency.

Conclusion

In addition to the stabilisation of operations at cane preparation, at the milling sections, and juice flow stabilisation at the process section, the Steam Pressure Stabilisation system outlined here maintains a stabilised operating condition at the evaporator station. Maintaining a fairly constant pan pressure at the evaporator station and live steam pressure at the boiler station will go a long way towards the achievement of the desired stabilised operation and improved efficiency of the whole plant.

MÉTHODES POUR STABILISER LA PRESSION—UNE NÉCESSITE
DANS L’INDUSTRIE SUCHRIÈRE

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MOTS CLEFS: Automation, Stabilisation, Pression Vapeur.

Résumé
On se sert de plusieurs systèmes de contrôles automatiques pour stabiliser les opérations en sucreries. La cristallisation discontinue affecte cette stabilité parce que sa demande de vapeur fluctue. Ce papier décrit un système qui contrôle et stabilise la pression de la vapeur pour les évaporateurs et pour les cuises. La vapeur pour les cuises est obtenue par prélèvement, ce qui donne une bonne économie, mais la variabilité de la demande affecte les évaporateurs, et donc le brix du sirop et la pression de la vapeur d’échappement. Des vannes spéciales sont utilisées pour contrôler la demande de vapeur et pour garder la pression de la vapeur des chaudières dans une fourchette acceptable. Ces effets de cascade stabilisent les pressions et l’opération des évaporateurs reste bonne. On peut donc augmenter le broyage et la performance des chaudières est meilleure. La performance de toute la sucrerie est améliorée et on économise l’énergie.

SISTEMA PARA LA ESTABILIZACIÓN DE LA PRESIÓN—NECESIDADES
DE LA INDUSTRIA AZUCARERA

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PALABRAS CLAVE: Automatización del Ingenio, Estabilización del proceso, Control de la presión del vapor.

Resumen
La estabilización general de las operaciones de un ingenio azucarero se logra mediante diversos sistemas de control automático para la operación continua de la planta azucarera. Dado que los tachos de tipo bache se utilizan para la cristalización, la demanda de vapor de proceso siempre fluctúa, afectando la estabilidad general del mismo. Este documento esboza un sistema que se ha implantado con éxito para controlar y estabilizar las presiones del vapor alrededor de las estaciones de tacho y del evaporador. El vapor que se requiere para la etapa de tachos se suministra desde la estación del evaporador mediante la adopción de técnicas extensivas de extracción de vapor, con el fin de lograr una mayor economía energética. Así, la fluctuación en la demanda de vapor de los tachos se transfiere a la estación del evaporador, afectando por tanto el desempeño del evaporador, con fluctuaciones en el brix del jarabe y la presión de salida del vapor. Se han introducido tanto una válvula de reducción de presión como válvulas para excedentes de sobreflujo, para cubrir la demanda fluctuante de los tachos mediante la alimentación del vapor directamente desde la caldera y con un efecto de cascada. Para mantener la presión del vapor de la caldera dentro de límites permitidos, se suministran los controles correctos de las válvulas. El efecto cascada asegura condiciones estables del vapor de escape y de las presiones de vapor de los tachos. Por tanto, se estabiliza el desempeño del evaporador, con lo que se obtienen tasas uniformes de evaporación y un brix constante en el jarabe. Lo anterior resulta en un incremento en la capacidad de trituración de la planta. Se elimina así la fluctuación en la presión del vapor de la caldera debido a la demanda fluctuante del proceso. Por tanto, se mejora aún más el desempeño de la automatización de la caldera. Además de otras medidas para la estabilización, resulta esencial el sistema de estabilización de la presión del vapor para el desempeño estable del evaporador. Lo anterior llevará a un incremento en la capacidad total de la planta y logrará una mayor economía del vapor.