1.
An introduction to balancing

1.0 The importance of comfort

The most important purpose of balancing a hydronic heating system is to ensure the comfort of the people who use a building.

When people know they will be comfortable, they will move in, and they will stay. And while they are in the building, they will be productive. We all know this from our own personal experience. If we are too hot or too cold, we will lose productivity, and eventually we will move to where we can be comfortable.

Comfort is an investment that can provide a prompt pay-back in the form of improved productivity, reduced absenteeism and lowered employee turn over.

Comfort translates directly into economic gain. Discomfort translates into economic loss.

1.0.1 Impact of balancing

If we analyze why buildings are designed as they are, we will find that "comfort for the occupants" is probably the most important reason. One of the most important aspects of comfort is the control of the indoor temperature. And the balancing valve, an inexpensive piece of equipment, can have a disproportionally large impact on how a building will perform its primary function.

Deciding whether to install balancing valves is the first step. Once the decision is made, the installation must be followed by professional adjustment of the balancing system. Then, the investment will begin to pay off, in two ways.

First, overall heating costs will drop. And second, now that they are comfortable, tenants and employees will be happier and more productive. They will be absent less and stay longer.

In the past, low energy costs allowed comfort to be maintained by casually manipulating the heat and cooling of a building, but the rise in the cost of energy and a greater understanding of the importance of comfort have led to the development of sophisticated control techniques.

The advantages of balancing can be easily obtained when fundamental components are properly employed on homogeneous installations.

1.0.2 Balancing as foundation

However, it is still unusual to find installations so well designed that the full energy savings and other benefits are realized.

Hydronic balancing provides the foundation for the control of the hydronic system. It makes it possible for the control system and the hydronic system to cooperate and accomplish energy savings without sacrificing comfort. Hydronic balancing will save energy by correctly distributing the heating and cooling in the proper proportions to the different parts of a building. Because it will also prevent overflows to the most favored parts of the system, it also reduces the circulated volume and the associated pumping costs.

Because the whole system will be homogeneous and predictable, it can be precisely engineered. Boilers, chillers, pumps, valves, pipes etc. can be sized without any unnecessary "safety factors." This results in savings that far overshadow the cost of installing balancing valves. Because the system is predictable, the control valves can be sized correctly. This correct sizing is essential for achieving stable control. Balancing valves make it possible to measure the flows in the different parts of the hydronic system. This measurement makes it possible to analyze, identify and resolve any problems.

1.0.3 Correct sizing

The correct sizing of automatic control valves is essential for the proper function of the automatic control system.

Unfortunately, many control valves are oversized, and are reminders of the past when systems were simpler, and the use of on/off control and three-way valves was common. The controls contractor often is provided only with the dimensioning flow, and has to use standard or typical differential pressures to calculate the valve size. A modest over-sizing will result in a significant downgrading of the control function. The installation of valves that are too large, at a premium cost, provides no benefits, but instead results in a poor control function.

The functions of automatic control valves and balancing valves are interrelated; therefore parts of this guide discuss automatic control valves.

The examples given in this guide refer primarily to heating systems but many also relate to cooling systems.

1.1 On what does energy consumption depend?

In a heating system, the energy that is consumed is to make up for the building heat losses, in order to maintain a desired level of comfort.

In an existing building, such losses depend on:
- Outdoor climatic conditions
- The building envelope materials and physical size
- The ventilation requirements
- The occupancy requirements
- The space comfort conditions

Since these factors are known from construction data, basic action to reduce heat loss is dependent on the indoor temperature, which should be kept to a minimum value compatible with comfort conditions.

Part of the heat loss is compensated by internal heat gains such as office equipment, lighting, etc. The energy consumed by the heating plant must, therefore, cover the uncompensated heat loss and the losses arising from inefficient generation and transfer of heat.

Any energy processing operation involves a loss which reduces available useful energy Eu (output) in relation to energy consumption Ec (input). The ratio Eu/Ec is the efficiency of the heating system.

1.1.1 Energy processing stages

Energy processing operations may be broken down into three major stages:

1. The generation of thermal energy in the boiler with losses in the chimney and in the boiler room at efficiency (n_p)
2. The transportation of hot water with heat losses and pumping energy at efficiency (n_D)
3. The heat emission from terminals with additional losses and/or fan consumption at efficiency (n_E)

Ec = Energy Consumed

$$= \frac{(\text{Heat Loss}) - (\text{Internal Heat Gain})}{(n_P)(n_D)(n_E)}$$

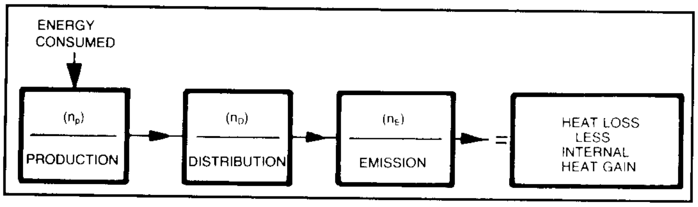

Fig. 1. Building energy usage

In terms of the installation, our potential actions to reduce energy consumption center on the following:

A. Limit heat losses by maintaining an appropriate space temperature which is:

- Constant while the premises are occupied
- Lower while the premises are unoccupied
- Making best use of free energy or internal heat gains

B. Increase production efficiency:

- Optimization of the combustion process
- Proper water flow through the boiler
- Appropriate generating capacity vs. load
- Reduction of losses when boiler is not in operation
- Optimization of the boiler operating cycles
- Optimization of the boiler in series
- Optimization of the water temperature

C. Improve distribution efficiency by balancing and measurement:

- If the water flow is too low, comfort conditions cannot be reached.
- If water flow is too high, light loads cannot be efficiently controlled.
- Reduce water temperature to optimize comfort vs. heat losses.

1.2 Summary

Hydronic balancing provides many advantages:

- Comfort level is improved, reducing complaints from the occupants
- Heating and cooling is evenly distributed to the different parts of the building
- Energy is saved by preventing over heating and over cooling
- The automatic control system and the hydronic system can cooperate, realizing the full potential of the energy saving strategies offered by the control system
- Permits the automatic control system to work
- It permits stable control
- Eliminates excessive flows in the most favored circuits, thereby reducing the circulated volume and the pumping cost
- Boilers, chillers, pumps, valves, etc., will not have to be oversized
- Flow can be measured in the different parts of the circuit, permitting analyzing of the system
- Correction of any "as built" condition which may have different characteristics than the original design
- The system can be brought back in balance after additions or modifications have been implemented
- The balancing valve can be used as a tool to solve many problems in hydronic and control systems
- Gives the designer control over the system

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