## DETERMINE PROPER SHEATH MATERIAL

Information is located in each product section throughout the catalog in regards to the sheath materials available. In surface or air heating, operating at high temperatures can cause oxidation and scaling of the sheath. This impedes the transfer of heat from the element, resulting in over-heating and failure. It is always safe to specify Incoloy in these situations. The additional cost of the element will be recovered by providing longer service. In the direct heating of liquids and gasses, corrosion will be an important consideration in the selection of an immersion heater. An extensive Corrosion Resistance of Sheath Materials guideline (24T) is provided later in this section. Besides the information there, note the following:

- The effects of the solution concentration.
- As heat is a catalyst in a chemical reaction, lowering the watt density and in effect the sheath temperature will prolong the life of the element(s).
- Mineral deposits contained in a water supply can build-up on the elements, reducing the transfer of heat. Sheath temperatures can elevate to the point of failure. Stainless Steel or Incoloy sheath material will not attract the deposits as copper will and can operate at higher element temperatures should the build-up occur. This provides longer heater life.

In essence, the sheath material selected must be compatible with the process environment and the heat requirement.

Depending upon the design, many heaters have the potential to produce sheath temperatures exceeding 1400°F. This is where the heat transfer path from the element to the material becomes so important. The more efficient the heat transfer, the less the temperature difference between the heater and the process. The medium plays a key role in the design of a thermal system, as seen in more detail later. Calculating the wattage requirement, the selection of the watt density, sheath material and the heater type are integral in the decision as to how to apply the heat to a process. **OGDEN** has been instrumental in providing information and assisting in the design of thousands of process heat and control applications. If the information for a particular application is not included here, contact **OGDEN**. With over 50 years of expeience on file, **OGDEN** may already have solved the problem.

## THERMAL SYSTEM DESIGN

In industrial processes, temperature is often the most important variable to control. Temperature variations cause changes in the chemical or physical state of most substances, resulting in changes in flow, viscosity, pressure, level or humidity. An arrangement of components designed to supply controlled heat is a Thermal System. The most sensitive control will not provide acceptable results if careful consideration is not given to the entire system design. As technology has focused increasingly on the application of electronics, control systems can be required to collect and retrieve data and communicate with computers or other controls. Even as industry moves toward the completely automated factory, process temperature control utilizes the same principles and theories whether accomplished by microprocessor or mechanically actuated thermostat.

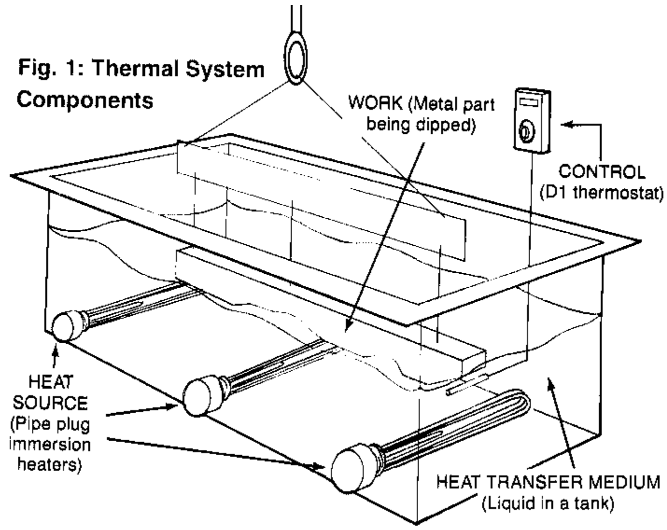
### THERMAL SYSTEM COMPONENTS

The four elements comprising a thermal system are:

1.) The work or load.
2.) The heat source.
3.) The heat transfer medium.
4.) The control system.

1.) The work is the material or product being processed. The heat demand may be steady, meaning that the material

**Fig. 1: Thermal System Components**




must be maintained at a constant temperature for a specified period of time. A bacteria culture in an incubating oven is an example of a steady system.

Often the heat demand is variable and cyclic. In this dynamic system, cold material enters the system for processing, absorbs heat, is removed, then replaced in the system by more cold material. An example of a variable or dynamic system is plastic injection molding equipment. The mold receives plastic material, heats, forms, cures then ejects the finished part. The process is repeated again and again.

2.) The heat source is the device that provides heat to the system. The source may be electric heaters, oil or gas fired systems, steam, or the process may be exothermic in that the system generates its own heat.

3.) The heat transfer medium is a solid, liquid or gas which transmits the heat generated from the heat source to the work. The transfer characteristics or conductivity of the material are significant in determining how fast temperature changes travel through the system, and thus, how close the system can be controlled.

4.) The control system includes the instrument that directs whether heat is on or off, depending on the difference between the desired temperature or control set point and the actual temperature.

### FACTORS AFFECTING SYSTEM ACCURACY

A product within acceptable quality tolerances with lowest possible scrap levels are the ultimate measures of system accuracy. Generally, a constant mean temperature and the system bandwidth determine accuracy. The system bandwidth is the temperature variance measured at the work *(Fig. 2)*. Several factors affect the accuracy of the system.

**Fig. 2: Control Terms**