Heat Pipe Applications Introduce

Most suitable where:

- Low humidity level necessary
- Humidity control required
- Air reheated after cooling in traditional HVAC system
- Large quantities of ventilation air needed

Some examples are:

- Electronic component production, assembly and storage
- Film drying, processing and storage
- Drug, chemical and paper manufacturing and storage
- Candy, chocolate processing and storage
- Swimming pool enclosures
- Hospital operating rooms
- Grocery stores
- Telephone exchanges, relay stations, clean rooms
- Underground silos

• Other Heat Pipe Applications

Heat pipes have been used for many applications:

- Remote heat rejection from a concentrated source (e.g. computer chip)
- Obtain uniform temperature
- Efficient heat exchangers

Die casting and Injection Molding

Die casting and injection molding processes, in which metal alloys or plastics are introduced in molten form into a die or mould and rapidly cooled to produce a component, often of considerable size and complexity, have enabled mass production on a considerable scale to be undertaken. The production rate of very small plastic components may be measured in cycles per second, while alloy castings such as covers for car gearboxes may be produced at upwards of one per minute. Aluminum zinc and brass are the most common metals used in the die-cast components, but stainless steel components may now be made using this technique.

The removal of heat during the solidification process is the most obvious requirement, and nearly all dies are water-cooled. However, difficulties are sometimes experienced in taking water-cooling channels to inaccessible parts of the die. A common solution is to use the inserts made of more highly conducting material such as molybdenum, which conducts the heat away to more remote water-cooling channels. Furthermore, it is often inconvenient to take water-cooling to movable or removable nozzles, sprue pins, and cores.

Possibly a more important aspect of die cooling is the need to minimize thermal shock, thus ensuring a reasonable life for the components. With quite large temperature differences between the molten material and the cooling water,

which must be tolerated by the intervening die, the life of the die can be shortened. What these parts clearly require is a means of rapidly abstracting heat from their working surfaces at a temperature more nearly approaching that of the molten metal.

Two more thermal problems may be mentioned. In some processes it may be necessary or desirable to heat parts of the die to ensure continuous flow of the molten material to the more inaccessible regions remote to the injection point. To obtain the subsequent rapid solidification, a change from heating to cooling is required in a minimum amount of time to keep cycle times as short as possible.

The heat pipe in its simple tubular form has properties that make it attractive in two areas of application in dies and moulds. Firstly, the heat pipe may be used to even out temperature gradients in the die by inserting it into the main body of the die, without connecting it to the water-cooling circuits.

Probably the most important application is in assisting heat transfer between the die face and the water-cooling path in areas where hot spots occur.

Cooling of Electronic Components

At present the largest application of heat pipes in terms of quantity used is the cooling of electronic components such as transistors, other semiconductor devices, and integrated circuit packages.

There are two possible ways of using heat pipes:

1. mount the component directly onto the heat pipe, and
2. mount the component onto a plate into which heat pipes are inserted.

Spacecraft

Heat pipes, certainly at vapor temperatures up to 200 °C, have probably gained more from developments associated with spacecraft applications than from any other area. The variable conductance heat pipe is a prime example of this "technological fall-out". In the literature can be found details about the following types of application:

- Spacecraft temperature equalization
- Component cooling, temperature control and radiator design
- Space nuclear power sources

  – Moderator cooling

  – Removal of the heat from the reactor at emitter temperature. (Each fuel rod would consist of a heat pipe with externally attached fuel).

  – Elimination of troublesome thermal gradients along the emitter and collector.

Thermal Transtech International Corporation

Heat Pipe Inserts for Thermometer Calibration

Heat pipe inserts have been developed at IKE, Stuttgart, for a variety of duties, including thermocouple calibration. The heat pipes are normally operated inside a conventional tubular furnace. The built-in enclosures provide isothermal conditions, a necessary pre-requisite for temperature sensor calibration. The isothermal working spaces can also be used for temperature sensitive processes, such as fixed-point cell heating, crystal growing and annealing.

Snow Melting and Deicing

An area of application, and one in which work in Japan has been particularly intense, has been the use of heat pipes to melt snow and prevent icing.

The operating principle of the heat pipe snow melting (or deicing) system is based upon the use of heat stored in the ground as the heat input to the evaporators of the heat pipes.

Energy Conservation

The heat pipe, because of its effectiveness in heat transfer, is a prime candidate for applications involving the conservation of energy, and has been used to advantage in heat recovery systems, and energy conversion devices.

Energy conservation is becoming increasingly important as the cost of fuel rises and the reserves diminish, and the heat pipe is proving a particularly effective tool in a large number of applications associated with conservation.

There are a large number of techniques for recovering heat from exhaust air or gas streams or from hot water streams. Details and explanations about heat pipe heat exchangers can be found in this material. Also, a lot of details can be found visiting the Web pages belonging to heat pipe manufacturers presented in this chapter.

Features of heat pipe heat exchangers that are attractive in industrial heat recovery applications are:

- No moving parts and no external power requirements, implying high reliability.
- Cross-contamination is totally eliminated because of a solid wall between the hot and cold fluid streams.
- Easy to clean.

- A wide variety of sizes are available, and the unit is in general compact and suitable for all.
- The heat pipe heat exchanger is fully reversible – i.e. heat can be transferred in either direction.
- Collection of condensate in the exhaust gases can be arranged, and the flexibility accruing to the use of a number of different fin spacing can permit easy cleaning if required.

The application of heat pipe heat exchangers fall into three main categories:

1. Recovery of waste heat from processes for reuse in the same process or in another, e.g. preheating of combustion air. This area of application is the most diverse and can involve a wide range of temperatures and duties.

2. Recovery of waste heat from a process to preheat air for space heating.

3. Heat recovery in air – conditioning systems, normally involving comparatively low temperatures and duties.

Preservation of Permafrost

One of the largest contracts for heat pipes was placed with McDonnell Douglas Corporation by Alyeska Pipeline Service Company for nearly 100,000 heat pipes for the Trans – Alaska pipeline.

The function of these units is to prevent thawing of the permafrost around the pipe supports for elevated sections of the pipeline. Diameters of the heat pipes used are 5 and 7.5 cm, and lengths vary between 8 and 18 m.

The system developed by McDonnell Douglas /8/ uses ammonia as the working fluid, heat from the ground being transmitted upwards to a radiator located above ground level.

Details and photographs of Trans–Alaska Pipeline can be found at this

High Temperature Heat Pipe Furnace

Under contract from the European Space Agency, IKE developed a high temperature heat pipe surface, for materials processing in a micro gravity environment in the temperature range 900 to 1500 °C /9/

Miscellaneous Heat Pipe Applications

To assist the reader in lateral thinking, a number of other applications of heat pipes are listed below.

- Heat pipe roll-bond panels for warming bathroom floors (Japan)
- Heat pipe-cooled dipstick for cooling motor bike engine oil (Japan)
- Passive cooling of remote weather station equipment (Canada)
- Cooling of drills (Russia)
- Thermal control of thermoelectric generators (USA)
- Cooling of gas turbine blades (Czech Republic)
- Thermal control of electric storage heaters (Byelorussia, UK)
- Cooling of semi-automatic welding equipment (Russia)
- Deicing fish farms and ornamental ponds (Romania)
- Heating heavy oil in large tanks (Romania)
- Cooling of soldering iron bit (UK)
- Cooling of bearings for emergency feed water pumps (UK)
- Cooling of targets in particle accelerators (UK)
- Isothermalisation of bioreactors (China)
- Cooling of snubber pins in the synthetic fiber industry (UK)
- Thermal control in electric batteries Dehumidifiers (USA)
- Car passenger compartment heating
- Domestic warm air heaters (USA)