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PROCESS DESIGN OF HOT OIL AND TEMPERED WATER CIRCUITS

(PROJECT STANDARDS AND SPECIFICATIONS)

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SCOPE

These Project Standards and Specifications are intended to cover the minimum requirements and recommendations deemed necessary to be considered in process design of "Hot Oil" and "Tempered Water" systems.

REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

ASME (The American Society of Mechanical Engineers)

"ASME Code", Section VIII, Division 1

DEFINITIONS AND TERMINOLOGY

No particular definition is implemented.

SYMBOLS AND ABBREVIATIONS

SYMBOL/ABBREVIATION	DESCRIPTION
ASME	The American Society of Mechanical Engineers
CWS	Cooling Water Supply
CWR	Cooling Water Return
DP	Differential Pressure
DT	Differential Temperature
FCV	Flow Control Valve
LHV	Low Heat Value
LIC	Level Indicator Controller
LG	Level Gage
OGP	Oil, Gas and Petrochemical

OD	Outside Diameter
PI	Pressure Indicator
TCV	Temperature Control Valve
TEMA	Tubular Exchanger Manufacturers Association, Inc
TI	Temperature Indicator
TIC	Temperature Indicator Controller
TT	Temperature Transmitter

UNITS

This Standard is based on International System of Units (SI) except where otherwise specified.

PROCESS DESIGN OF HOT OIL SYSTEM

General

A simplified schematic of major components of a hot oil system is given in Fig. 1. The heat transfer medium is pumped through a fired heater to the heat exchanger and returns to the pump suction surge tank. In some cases a fired heater may be replaced by a waste heat source, such as the exhaust stack of a gas turbine.

While the system is ordered and designed as a packaged system, all necessary equipment such as ladders, and platforms, guards for moving parts, etc., shall be supplied as part of the package.

Indoor equipment shall be suitably protected against damage by infiltration of moisture and dust during plant operation, shutdown, wash down, and the use of fire protection equipment.

Outdoor equipment shall be similarly protected, and in addition, it shall be suitable for continuous operation when exposed to rain, snow or ice, high wind, humidity, dust, temperature extremes, and other severe weather conditions.

The system shall be laid out such that to make all equipment readily accessible for cleaning, removal of burners, replacement of filters, controls and other working parts and for adjustment and lubrication of parts requiring such attention. For similar reasons, the heater front and rear doors shall be hinged or deviated.

Maintenance tools specially designed for the equipment shall be furnished with the system.

Spare parts must be readily available. If a stock of parts is not maintained by the manufacturer, critical spare items shall be furnished with the system.

Advantages and Disadvantages of Hot Oils

- Advantages

  The advantages of hot oils are:

  - Low vapor pressure at ambient temperature.
  - Always liquid and easy to handle.
  - Blended for a specific temperature range.
  - Higher specific heat than normally occurring hydrocarbons.

- Disadvantages

  The disadvantages of hot oils include:

  - Escaping vapors are environmentally undesirable.
  - When overheated, the oils will oxidize and coke on the fire tube. Also, they can be ignited.
  - Ethers if used are expensive.
  - Ethers are hydroscopic and must be kept dry.

Hot Oil Heater Application

These heaters furnish a heating bath 300°C or higher, which is hot enough for process applications such as dry desiccant or hydrocarbon recovery regeneration gas. Another less severe application is heavier hydrocarbon vaporization prior to injection into a gas pipeline to raise the heating value.

Manufactured heat transfer oils are blended for about 90-95°C operating range. For example, Fig. 2, gives typical heat transfer properties for a 150 to 300°C polyphenyl ether.

Design

The following features and criteria shall be considered in process design of each component of the hot oil system.

1. Heater design

   a. Process design of the heater is critical for satisfactory operation. The heat transfer fluid must have sufficient velocity, generally 1.2 to 3 m/s, to avoid excessive film temperatures on the heater tubes.

   b. Design and capacity of the heater should be limited so that the maximum film temperature does not exceed the maximum recommended operating temperature of the fluid.

   c. Hot spot occurrence should be avoided, since it can lead to tube failure and fluid degradation.

   d. The heater shall be rated for the specified output. Multiple identical units may also be employed for the designed total heat load, but care shall be taken in system design to ensure adequate and proportional flow through the heaters.

   e. The preferred thermal efficiency of the heater to be 80% based on LHV of fuel. The contractor shall specify the expected and guaranteed values for the thermal efficiency and the basis for their estimation.

   f. Based on total outside surface area of the firetube(s) and the return flue(s), the average heat flux shall not exceed 17.35 $kJ/s.m^2$. The flame characteristics and combustion chamber design shall ensure that the maximum heat flux at any point is limited to 23.66 $kJ/s.m^2$.

   g. Heating medium (hot oil) shall clearly be specified and it's discharge temperature from the heater shall be limited to a specified value, in data sheet.

   h. Under normal operating conditions, the rise in heating medium temperature across the heater shall not exceed the allowable DT specified in the data sheet.

   i. The heater shall be designed to give an efficient heater operation over the complete operating load range.

   j. Each heater (in case the use of multi-heater units), shall have a self-supporting stack designed to carry the total exhaust under the maximum firing conditions.

2. Firing system design
   a. The hot oil heater shall be designed for a continuous and reliable operation.
   b. The burner(s) shall be designed for a minimum of 120 percent of normal full load firing and be suitable for firing the specified fuels (oil, gas or both) without undue maintenance or adjustment.
   c. In case of a forced-draft type heater the burner design shall incorporate air/fuel ratio system(s) to ensure complete combustion with minimum amount of excess air. The air/fuel ratio system shall be effective throughout the burner firing range i.e., from low to high fire positions.
   d. The burner nozzles and other parts exposed to the radiant heat of the combustion chamber shall be made from heat resisting alloy steel.
   e. The burner fuel and air openings shall be arranged to provide suitable velocities for complete mixing resulting in efficient combustion of the fuel.
   f. Each burner shall have observation ports to permit sighting and inspection of the flame.
   g. Suitable ignitor(s) shall be provided for firing fuel oil or gas and shall be of adequate output to permit safe ignition of the fuel.
3. Combustion air fan design

   In case of forced-draft type heater the following should be considered:
   a. The fan shall be designed for maximum ambient temperature.
   b. The fan(s), performance shall be stable over the complete firing range i.e., maximum firing down to shut off.
   c. Inlet screens shall be provided at fan(s) inlet.
   d. Combustion air fan(s) shall be sized to handle a minimum of 120 percent of the normal full quantity of combustion air.
   e. Outlet ducts of air fan (s) shall have some equipment like damper(s) for adjustment of the amount of intake air to the heater.
4. Heater control and instrumentation

   The heater package shall be provided with the following control and instrumentation as minimum:
   a. Fuel gas/oil control system complete with:
      - pressure gages in important locations;

- pressure regulators;
- pressure relief valves;
- flow control valves(s) on heater inlet line;
- strainers;
- isolating valves.

b. Fuel gas/oil emergency shut-off valve.

c. Heater TIC (modulating type) for hot oil temperature control.

d. Heater manual control for fire regulation.

e. Temperature switches shall be supplied for the following alarm and shutdown functions:
   - hot oil high temperature alarm;
   - hot oil high high temperature shutdown;
   - hot oil low temperature alarm;
   - stack high temperature alarm;
   - fuel oil low temperature alarm.

f. Pressure switches shall be supplied for the following alarm and shutdown functions:
   - hot oil high pressure alarm;
   - hot oil low pressure alarm;
   - *fuel gas/oil high supply pressure alarm;
   - *fuel gas/oil high supply pressure shutdown;
   - *fuel gas/oil low supply pressure alarm;
   - *fuel gas low low supply pressure shutdown.

g. Flow switches installed on the flow transmitter output shall be supplied for the following functions:
   - turning Unit down to low flame position on low flow condition;
   - shutting Unit down (including circulation pumps) on low low flow condition.

h. Additionally, the following instrumentation shall be provided on the hot oil heater:
   - pressure gage complete with isolation and bleed valve;

- temperature indicators complete with thermowells for hot oil inlet and outlet streams;
- stack exhaust temperature indicator complete with thermowell;
- ASME rated relief valve(s), factory set and sealed and located suitably. Relief valves shall have stainless steel trim.

i. Automatic start up/shutdown sequence control is normally not recommended, but if specified by the Company shall consist of:
  - pre-ignition purge of the combustion chamber;
  - ignition;
  - pilot proving;
  - firing rate modulation between low flame position and the maximum output;
  - post purge after shutdown.

j. The burner management system if specified by the Company shall be housed in a locally mounted panel, suitable for the area classification in which it is installed.

k. The burner management system shall incorporate a remote shutdown facility so that the main burner(s) and pilot(s) can be extinguished by a push-button located in central control room.

l. All other instrument, and controlling systems as per Vendor specification such as flame failure detector, pilot flame monitoring etc., should also be considered.

* Pressure switches shall be installed on each fuel supply line.

5. Hot oil surge tank design

a. A surge tank shall be provided, suitably sized to handle expansion of inventory in whole system.

b. The surge tank shall be arranged on the pump suction side and shall be blanketed with fuel gas or inert gas.

c. The surge tank shall be located inside the heater building.

d. The surge tank shall be provided complete with the following:
  - Level gage(s), spanning the entire operating range.
  - Pressure gage.
  - Pressure relief valve.