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Guidance on Practice for Process Heating in Lubricant Blending Plants

GP 82-54

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GP 82-54. This Guidance on Practice (GP) makes reference to parts of heritage documents from the merged BP companies as follows.

BP

RP 22-1	Fired heaters
RP 26-1	Heat exchange equipment
RP 32-2	Site inspection, testing and precommissioning of new plant
RP 32-4	Inspection and testing of in-service civil and mechanical plant - technical guidance
RP 42-1	Piping systems
RP 52-1	Thermal insulation
PTA FE-BLR-00-G	Fabricated Equipment: Boilers / Steam Generators Guide
PTA BD-ELO-00-E	Basic Design: Equipment Layout and Spacing Design Specification

ARCO

Engineering standard 30 Fired Process Heaters
Engineering standard 200 Piping Design

Revision History		
Rev	Date	Comments
1	15/04/2005	Initial draft issued to Engineering network for comment/approval
2	06/06/2005	Final version submitted to ETP

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Introduction

Efficient and effective heating is a requirement of most lubricant blending processes, both to reduce the viscosity of raw materials to aid pumping and decanting into the blend vessels, and to improve miscibility of the components in the blend vessel (and hence reduce blending time and ensure correct product quality). Some formulations also require heating to initiate or maintain a chemical reaction during the blending process. This document defines the principal requirements for such heating systems as guidance for their design, operation and maintenance.



1. Scope

This document is intended to give plant engineers an understanding of the technical considerations to be made when defining a process heating installation, and of the fundamental design and performance parameters, to support technical discussions with equipment designers, suppliers and other professional engineers.

It also gives guidance on the safe and efficient control of temperature at the point of application of the heating (blending vessel, drum heating cabinet etc) and the requirements for maintenance of the system and its principal elements.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

API: American Petroleum Institute

API RP 521	Guide for Pressure-relieving and Depressuring systems
API STD 560	Fired Heaters for General Refinery Service
API 630	Tube and Header Dimensions for Fired Heaters for Refinery Services
API STD 2510	Design and Construction of Liquefied Petroleum Gas (LPG) Installations
API 5L	Specification for line pipe

ASME: American Society of Mechanical Engineers

ASME 801756	Boiler and Pressure Vessel code: • Section I; for equipment directly associated with Steam generation • Section VIII: Division 1, for equipment in which Steam is generated incidental to the operation of a processing system, or for process oils and parts not covered in Section I.
ASME PTC 4.1	Power Test code for Steam Generating Units
ASME B.31.3	Plant piping

BP Engineering Technical Practices

GIS 122-1	Fired Heaters to API 560
GP 12-40	Guidance on Practice for Electrical Trace Heating
GP 82-11	Vertical and Horizontal Above Ground Atmospheric Storage Tanks
GP 82-21	Guidance on Practice for Drum Decanting in Lubricant Blend Plants
GP 82-52	Storage and Handling of Flammable Materials
GP 82-53	Site Drainage and Containment



BS: British Standards

BS 2869: part 2	Specification for Fuel Oil for Agricultural and Industrial Engines and Burners
BS 5500	Specification for Unfired Fusion Welded Pressure Vessels
BS 5970	Code of Practice for Thermal Insulation of Pipe work and Equipment
BS 799: part 4	Specification for Atomizing Burners (other than monobloc type) together with Associated Equipment for Single Burner and Multi-burner Installations
BS EN 10216	Seamless steel tubes for pressure purposes
BS 806	Design and construction of ferrous piping systems for and in conjunction with land boilers

DIN: Deutsches Institut für Normung

DIN 4754:	Heat Transfer Systems operating with organic media - Safety Requirements and Testing
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NFPA: National Fire Protection Agency

NFPA 30:	Flammable and Combustible Liquids Code
NFPA 31:	Standard for the Installation of Oil-burning Equipment
NFPA 58:	Liquefied Petroleum Gas Code
NFPA 85:	Boiler and Combustion Systems Hazards Code
NFPA 8501:	Single Burner Boiler operation
NFPA 8502:	Prevention of Furnace Explosions / Implosions in Multiple Burner Boiler-Furnaces

3. Informative references

The following documents give additional reference material and guidance:

- Organic Thermal Fluid heating systems RC 26 (The Loss Prevention Council - UK)
- A guide to the installation of Thermal Fluid systems (Babcock Wanson - UK)
- Spirax-Sarco Training Manuals (Steam process heating) [Link](#)

4. Terms and definitions

For the purposes of this GP, the following terms and definitions apply:

Battery limit

The boundary of a system or zone of a system, for example the interface between the process heating pipework and a heat exchanger

Condensate

The water resulting from condensation of the Steam when transferring its heat to the process, returned to the primary heat source for reheating.

Consumer

The process or utility unit that will burn the fuel supplied.



Combustion system

The system within the consumer's plot that controls, safeguards and burns the fuel in the fired application.

Demand factor

The proportion of total thermal load of the plant typically demanded during normal operation. The factor will vary according to the scope and operating characteristics of the plant, and the type of load but would typically be 50% for blending vessels and 80% for storage tanks.

Duty cycle

The length of time and frequency of operation of any component in the system, including the required time to raise the process to the specified temperature.

Expansion vessel

A vessel designed to accommodate expanded volume and surge of the HTF.

Feed water tank

A reservoir of returned condensate and treated make-up water for feeding the Steam boiler. Feed water tanks are normally heated to at between 80°C and 90°C (175°F to 195 °F) to reduce the amount of oxygen entering the boiler.

Fuel

A substance that can provide self-sustaining combustion in air and provide a source of useful heat.

Fuel gas

A gaseous fuel generally from local mains supply or storage tank.

Fuel oil

A term used to describe oil-based liquid fuels generally, but excluding low boiling point fuels such as liquid butane or naphtha. The term "light" refers to fuel oil having a relatively high proportion of volatile components and low viscosity. The term "heavy" refers to fuel oil having a relatively high proportion of high boiling point residues and high viscosity.

Fuel system

The system which receives a fuel or a number of fuel component streams, stores the fuel as required, conditions the fuel such that it is suitable for use in the consumer's combustion system(s), and distributes the fuel to the consumer(s) at these required conditions.

Heat transfer fluid (HTF)

A fluid capable of transporting heat energy within a specified temperature range. Generally, this includes synthetic aromatic, silicone-based and a limited selection of mineral-based oils.

Heater

The heat energy producer in the system sometimes referred to as the Boiler.

Heat exchanger

A device for transferring heat from the HTF or Steam into the process.

HTF system

A system which includes all heaters, piping, pumps, vessels, heat exchangers and auxiliaries that constitute the closed circuit containing the HTF.



Maximum allowable bulk temperature

The maximum bulk temperature of the HTF allowed anywhere in the circuit, as specified by the manufacturer.

Maximum film temperature

The maximum temperature to which the HTF may be subjected in the system. This highest temperature is on the tube inner wall of the heater skin and is determined by the heat flux and heat transfer coefficient.

Return temperature

The temperature at which the HTF or condensate returns to the heat source.

Steam

Special case of heat transfer fluid. The Steam is used as heat transfer medium and is returned as condensate to the Steam boiler.

Storage tank

A tank for storage of HTF, also capable of retaining the full HTF volume in the system in case of need to drain the circuit.

Supply temperature

The temperature at which the HTF is made available to the battery limit of the users.

Thermal Fluid

An alternative term for HTF

5. Symbols and abbreviations

For the purpose of this GP the following symbols and abbreviations apply:

HTF	Heat transfer fluid
IBC	Intermediate Bulk Container of typically 1 000 l (250 gal) capacity
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
NPSH	Nett Positive Suction Head
PPE	Personal Protective Equipment

6. General design considerations

- All process heating installations shall be designed by, and procured from, reputable companies with proven expertise in this field, since there is a very significant HSSE risk to plant and personnel if failure of the system were to occur.
- The following sections describe the general considerations to be made when defining and specifying the heating system.



6.1. System zoning

- a. The process heating system should be divided into zones, each with differing duty requirements. A lubricant blending plant will typically require two zones, divided as follows:
 1. Steady state demand requiring constant, relatively low temperatures. This is typically required for base oil and additive storage tank heating.
 2. Short term demand requiring relatively high temperatures and rapid response to control signals. This is typically required for blending vessels and additive drum heating cabinets.
- b. In more complex plants, each of these zones should be further divided into sub-zones to facilitate isolation, maintenance and later addition of further process elements (e.g. blenders)

6.2. Thermal capacity

The thermal capacity required for a system is calculated from a number of parameters, including:

- a. Number of users in the system (e.g. blenders, storage tanks)
- b. Temperatures to be maintained or achieved in each user
- c. Duty cycle for each user
- d. Demand factor(s) for the system and zone(s)
- e. Ambient temperatures
- f. Anticipated system losses (e.g. by radiation from pipework and users)

Due to the differing duty cycles and demand factors, separate calculations are required for each zone. The final estimate will be a sum of the requirements for each zone.

Annex B gives guidance for the calculation of individual thermal load for each element in a typical system.

6.3. Heating medium

The heating medium may be low pressure Steam at typically 2-4 bar (30 - 60 lb/in²) or Heat Transfer Fluid (HTF). For ancilliary plant units (e.g. drum heating) radiant or conductive electric heating may be considered. The following sections summarise the relative characteristics of Steam and HTF systems.

6.3.1. Steam

- a. Benefits
 1. Good heat transfer characteristics (high heat transfer coefficient, good latent heat characteristics, heat transfer at constant temperature)
 2. Relatively simple circulation and control systems required (no circulation pump required)
 3. Good thermal stability
 4. Readily available heat transfer fluid (water)
 5. No fire hazard from heat transfer fluid
- b. Disadvantages
 1. Pressurised system requiring care in installation and maintenance
 2. Boiler can be complex

