

SCOoPE Webinar Series Chapter 9

“EFFICIENT GENERATION OF STEAM AND HOT WATER IN FOOD INDUSTRY”

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1



EFFICIENT GENERATION OF STEAM AND HOT WATER IN FOOD INDUSTRY

PART I. THEORY

1. STEAM SYSTEMS
 - 1.1 STEAM GENERATION SYSTEMS
 - 1.2 FUELS USED IN BOILERS
 - 1.3 ENERGY ANALYSIS FOR A STEAM GENERATION SYSTEM
 - 1.4 HEAT LOSS FROM A BOILER SYSTEM
2. HOT WATER SYSTEMS
3. PROCESS HEATING SYSTEMS

PART II. APPLICATIONS IN FOOD INDUSTRY

4. PRODUCTION PROCESSES THAT REQUIRE STEAM
5. FOOD PROCESSING EQUIPMENT THAT USE STEAM
 - 5.1 SHELL AND TUBE HEATER
 - 5.2 STEAM INJECTION HEATER
 - 5.3 STEAM INFUSION
 - 5.4 STEAM JACKETED KETTLE
 - 5.5 DRUM DRIER
6. FOOD PASTEURIZERS



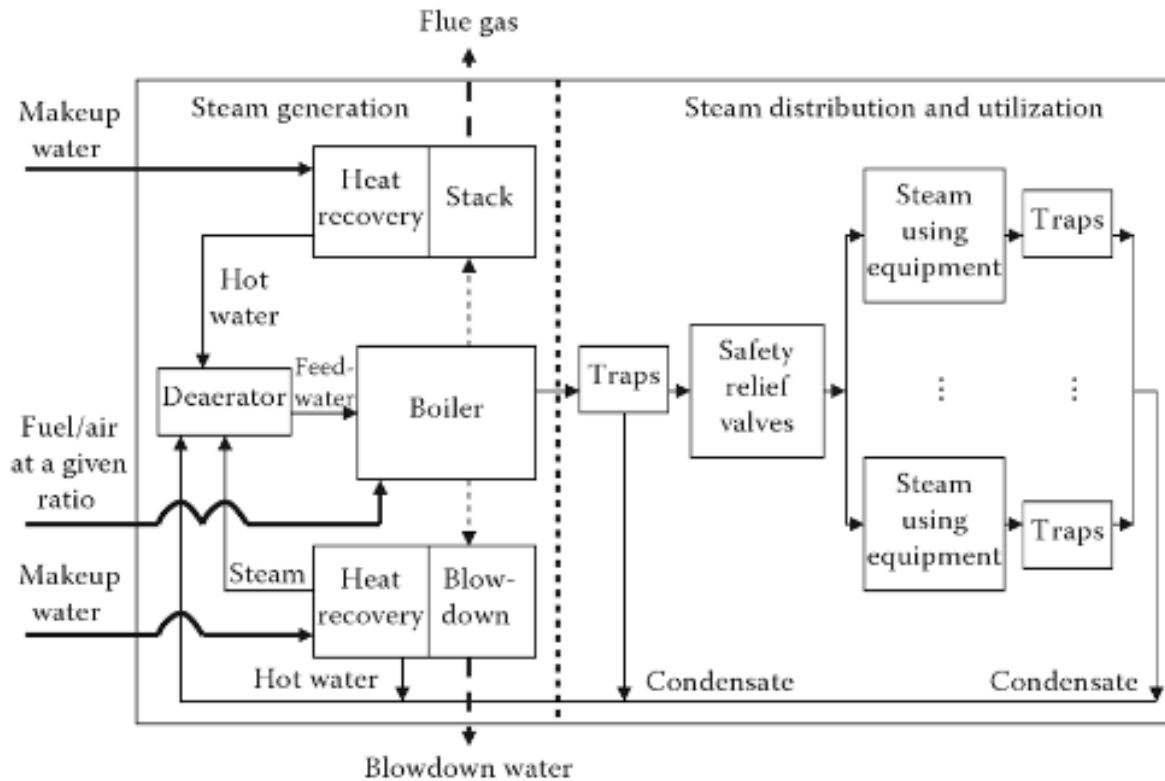


MAIN STEAM-DRIVEN PROCESSES IN AGRO-INDUSTRY

- cooking
- concentrating liquid foods
- drying
- sterilizing
- mechanical power and electricity generation in some food processing facilities.



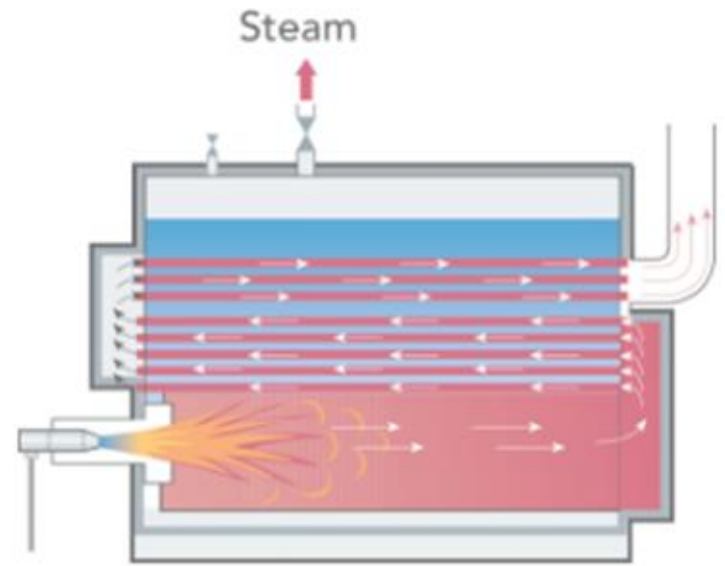
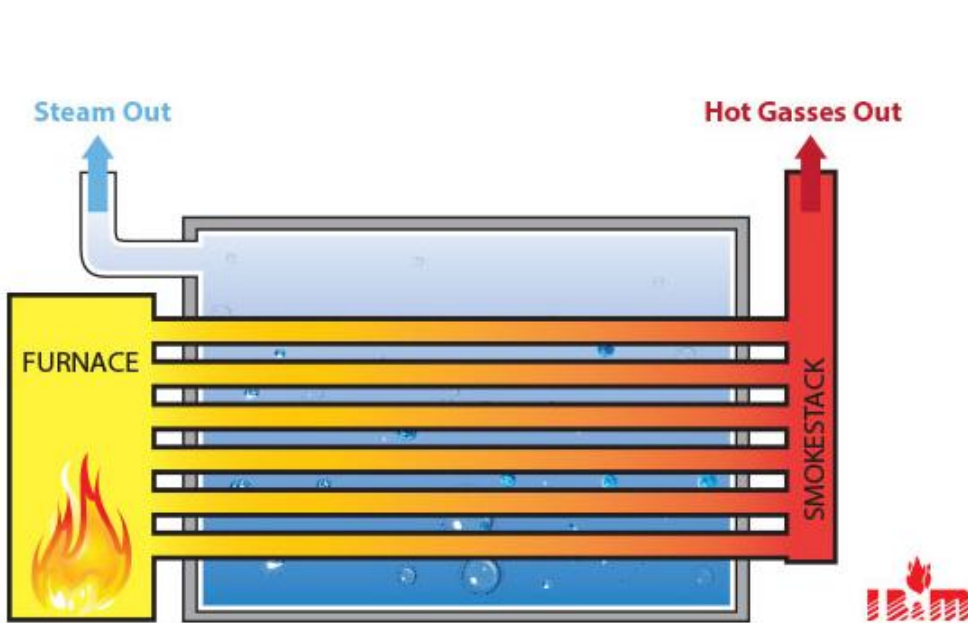
TYPICAL STEAM GENERATION AND DISTRIBUTION SYSTEM IN A FOOD PROCESSING PLANT



Wang, 2008



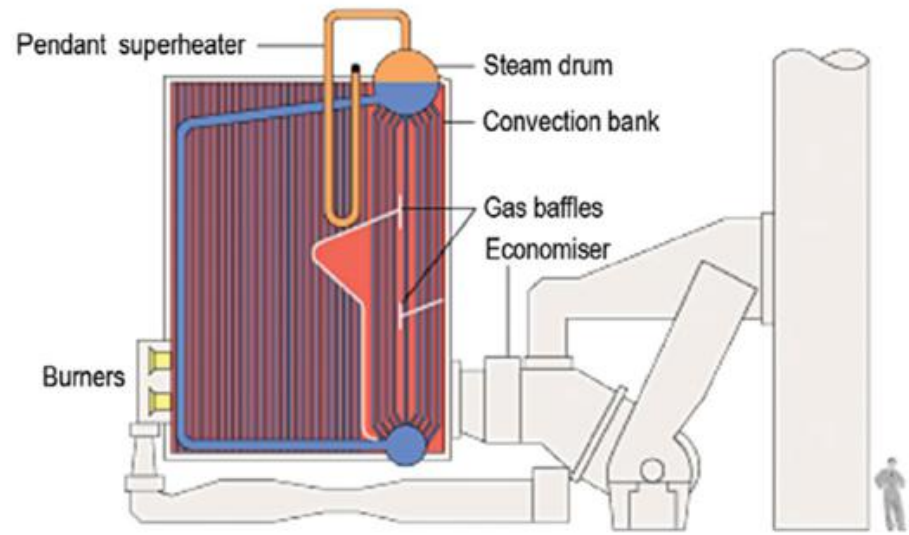
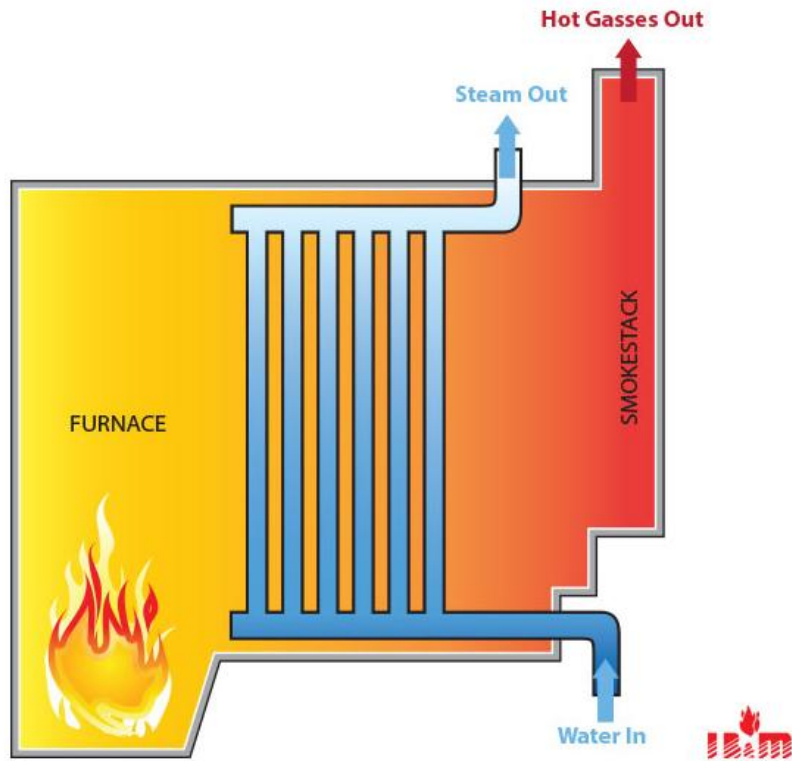
A TYPICAL FIRE-TUBE BOILER INSTALLATION



Principle of the fire tube boiler.

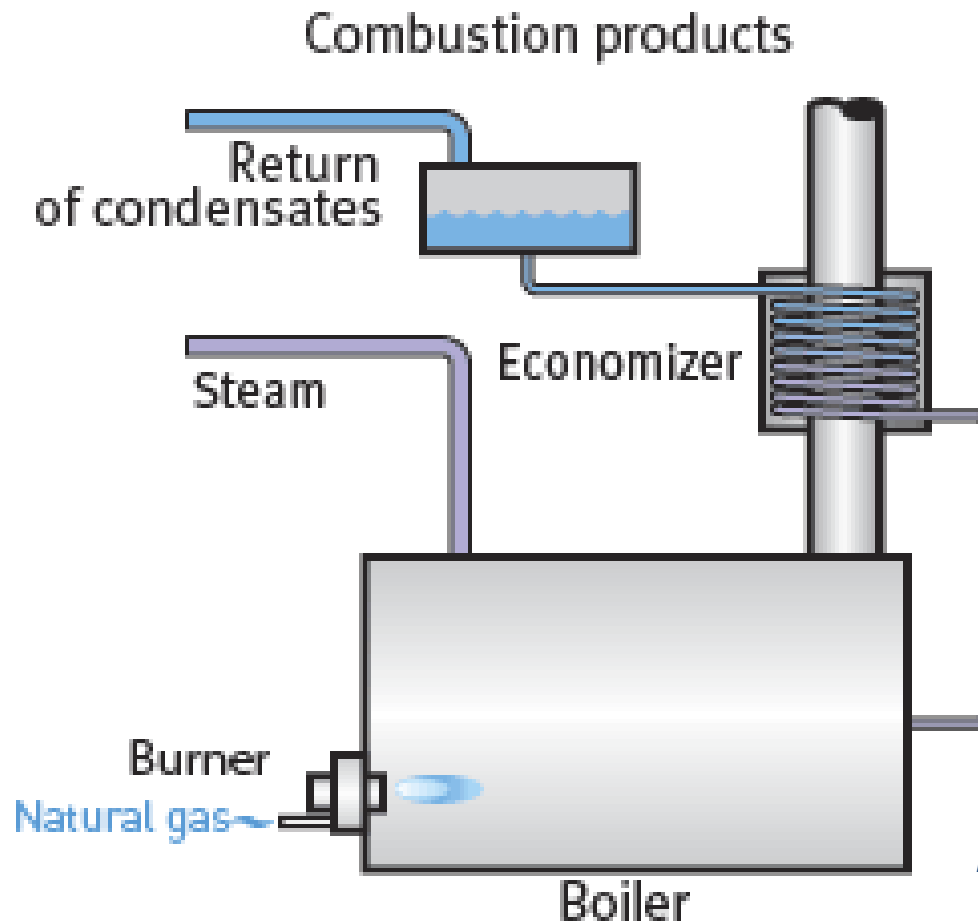


WATER-TUBE BOILER





BOILER STACK ECONOMIZER



<https://goo.gl/images/pWUmU8>





BOILER BLOWDOWN

Dissolved solids and particles in the make-up water will remain in the boiler when steam is generated.

During operation, the **Total Dissolved Solids (TDS)** builds up finally reaching a concentration level where the operation of the boiler becomes impossible.

If solids are not purged from the boiler they can lead to: scale formation, carryover, corrosion, embrittlement.

To reduce the concentration of such solids, a certain amount of water is removed from the boiler frequently, which is called **blowdown**.

In general, short frequent blowdowns are more effective in removing boiler water sludge than a one long infrequent blowdown.

There are two types of blowdown: bottom and surface.

Bottom blowdown is a manual process to remove the dissolved solids that have accumulated on the bottom of the boiler.

Surface bowdown, also known as top blowdown, removes solids that are floating on or near the surface of the water in the boiler.



DEAERATORS

A water treatment unit is required to control the acidity and to remove dissolved gases such as air in the boiler water. Before the water enters the boiler, all dissolved gases must be removed to minimize corrosion and protect the boiler equipment.

A good deaerator is essential to trouble-free boiler operation.

Deaerators can use an **atmospheric tank** or a **pressurized tank**.

The main difference between an atmospheric deaerator and a pressurized deaerator is the type of steam regulator used. Atmospheric units have a temperature regulator, while pressurized ones have a pressure regulator.

Temperature regulators are not as responsive as pressure regulators.

When a pressurized tank is used, deaeration takes place in two stages: the first stage is a spray assembly; the second stage will use either an atomizer or trays.

Atomizer or spray-type deaerators use a high-velocity steam jet to remove gases. Tray type deaerators use the agitation created by spilling the water over several stacked plates usually arranged in a staggered pattern.

24-01-2018

9





THE ADVANTAGES AND DISADVANTAGES OF INDUSTRIAL FUELS

Fuel	Heating Value (MJ/kg)	Price	Cost (\$/GJ)	Availability	Combustion Technology	Emission Control	Handling
Coal	30	35–70 \$/ton	1.5–3	Moderately abundant	Mature	Difficult (NO _x and SO _x)	Complex
Fuel oil NO 6	42	1–2 \$/gallon	6–13	Moderately abundant	Mature	Difficult (NO _x and SO _x)	Simple
Natural gas	53	5–10 \$/GJ	5–10	Moderately abundant	Mature	Easy	Simple
Organic wastes	20	—	—	Abundant	Immature	Easy	Complex



ENERGY ANALYSIS FOR A STEAM GENERATION SYSTEM

The boiler efficiency, η_b , can be considered as the product of two components: the combustion efficiency, η_c , of fuels and the heat exchanger efficiency, η_h .

$$\eta_b = \eta_c \times \eta_h$$

HEAT LOSS FROM A BOILER SYSTEM

The energy losses of a steam generation system or boiler could include:

- Flue gas including the sensible heat in the dry flue gas, water vapor formed by the combustion of hydrogen in fuels, and the moisture in fuels and combustion air.
- Incomplete combustion.
- Boiler blowdown water.
- Fouling of heat transfer surface.
- Heat convection and radiation loss from the hot boiler surface.

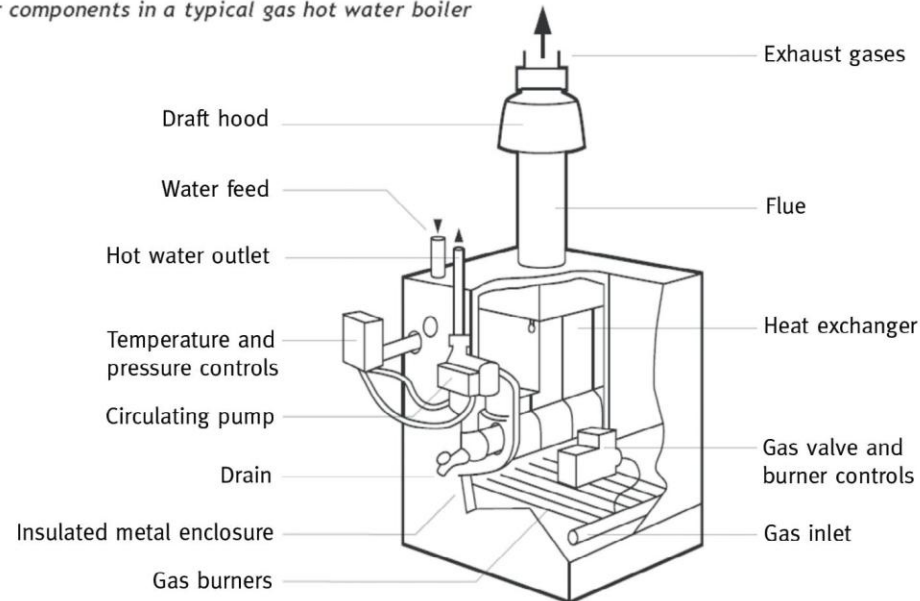


HOT WATER SYSTEMS

An industrial hot water system generally consists of:

- Hot water generator (sometimes called a hot water boiler): produces hot water at temperatures required by your process usually less than 100°C.
- Hot water pump: supplies hot water to the plant.
- Flue: extracts the exhaust gases from the boiler.
- Piping: carries the hot water around the plant.
- Insulation: (sometimes called lagging): reduces heat loss from piping and other equipment.

Major components in a typical gas hot water boiler

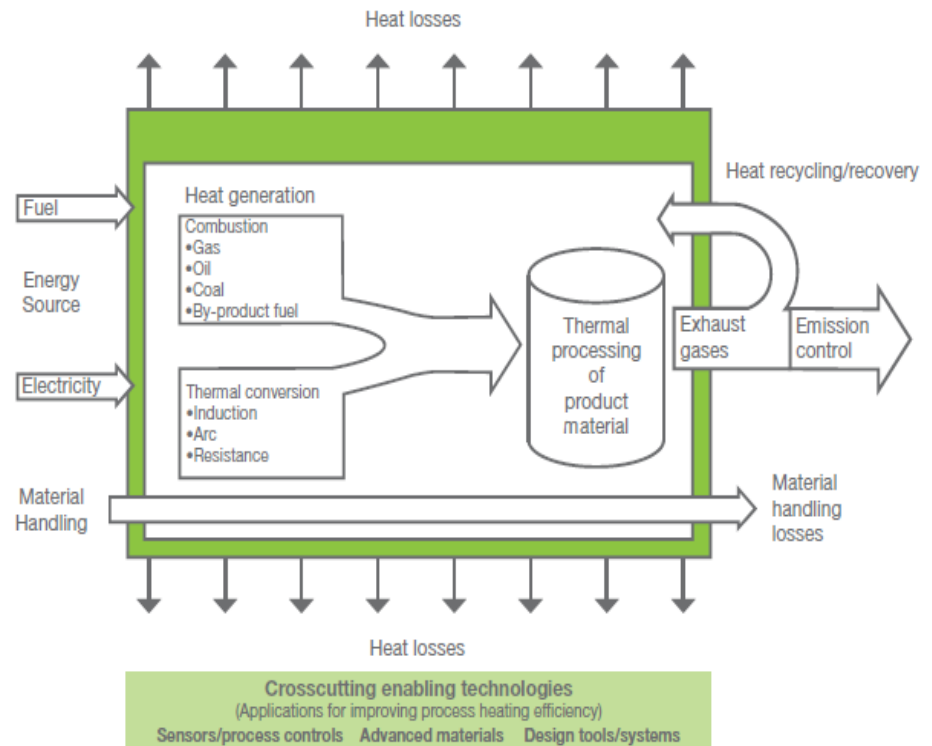




PROCESS HEATING SYSTEMS

Key components in a process heating system are:

- **fuel or electricity supply** – gas line, electricity distribution board
- **heat generation equipment** – boiler, furnace, dryer, resistance
- **heat transfer method** – convection, radiation, fluid heat transfer
- **material handling system** – fluid, conveyor, roller, rotary heater
- **heat recovery system** – heat exchange between exhaust gases and intake combustion air
- **exhaust emissions** – furnace flue.



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PROCESS HEATING CLASSIFICATION

Furnace Classification Method	Equipment/Application Comments	Primary Industries
Batch and continuous		
Batch	Furnaces used in almost all industries for a variety of heating and cooling processes	Steel, aluminium, chemical, food
Continuous	Furnaces used in almost all industries for a variety of heating and cooling processes	Most manufacturing sectors
Type of heating method		
Direct fired	Direct-fired furnaces using gas, liquid or solid fuels, or electrically heated furnaces	Most manufacturing sectors
Indirect fired	Heat treating furnaces, chemical reactors, distillation columns, salt bath furnaces	Metals, chemical
Type of energy used		
Fuel fired	Process heaters, aluminium and glass melting furnaces, reheat furnaces, ovens	Most manufacturing sectors
Electrically heated	Infrared ovens, induction melting and heating furnaces, electric arc melting furnaces	Metals, chemical
Steam heated	Dryers, fluid heating systems, water or slurry heaters, tracing	Pulp and paper, chemical, petroleum refining, food
Other	Air heaters, polymerising heaters, frying ovens, Chemical, food digesters, evaporators	

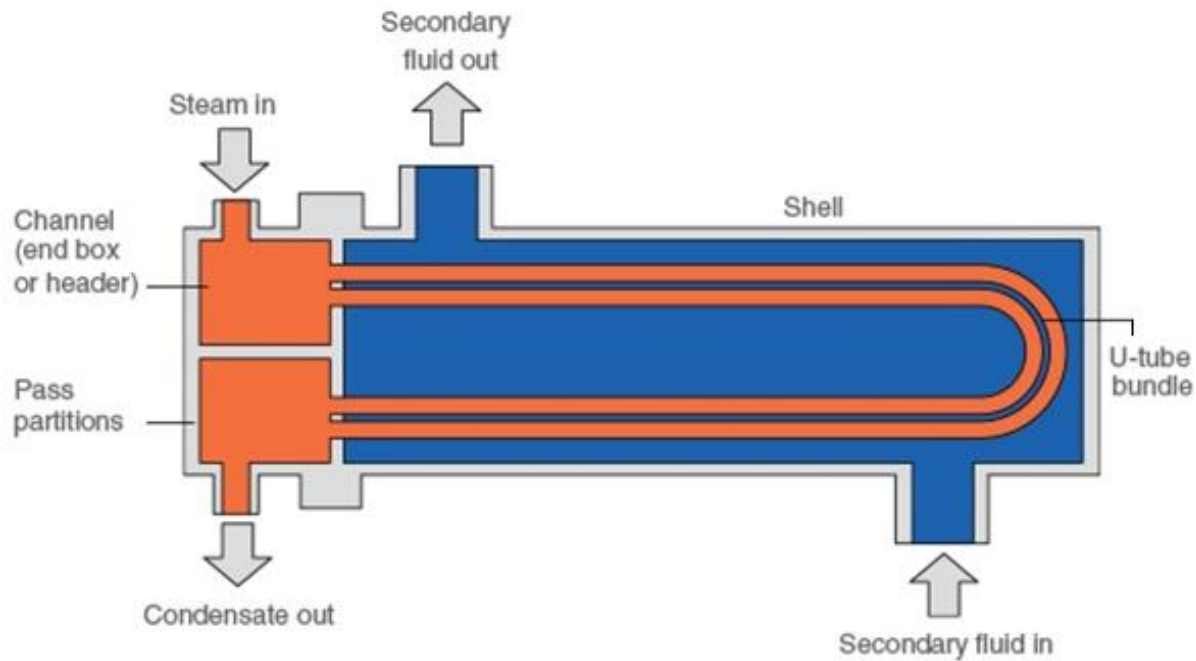
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14





A TYPICAL SHELL AND TUBE HEATER

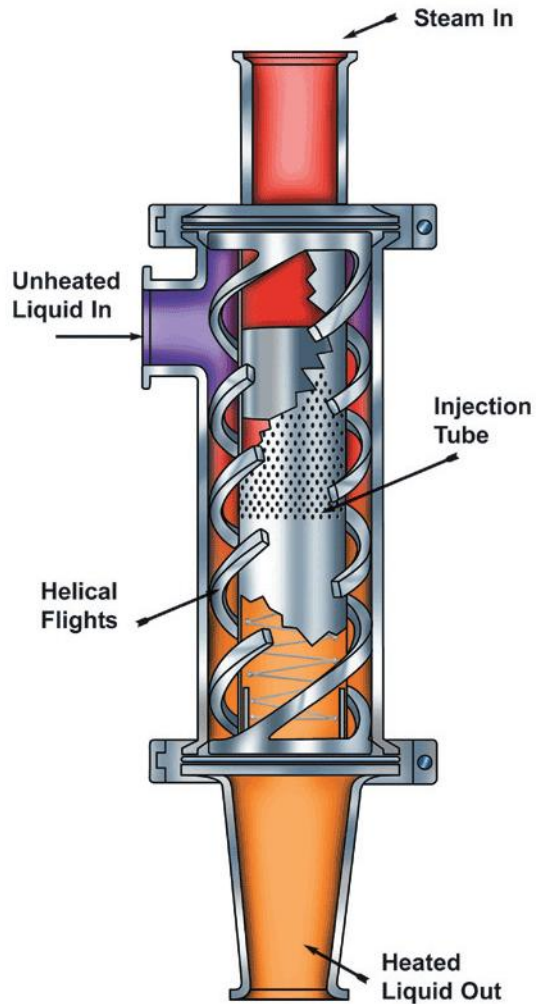


Schematic diagram of a shell and tube heat exchanger





STEAM INJECTION HEATER



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16





STEAM-JACKETED KETTLE



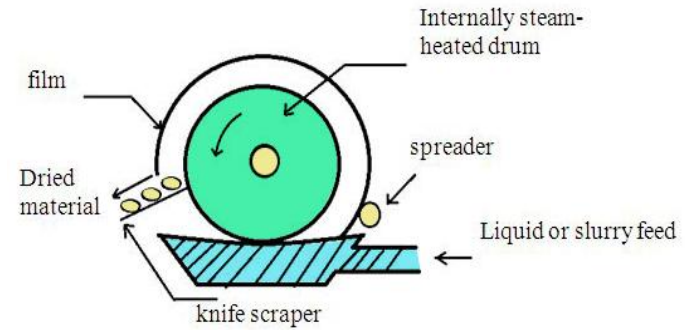
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17

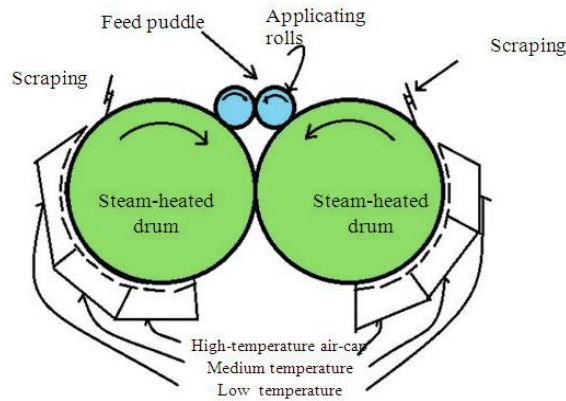




DRUM DRIERS



Single drum dryer



Double drum dryer



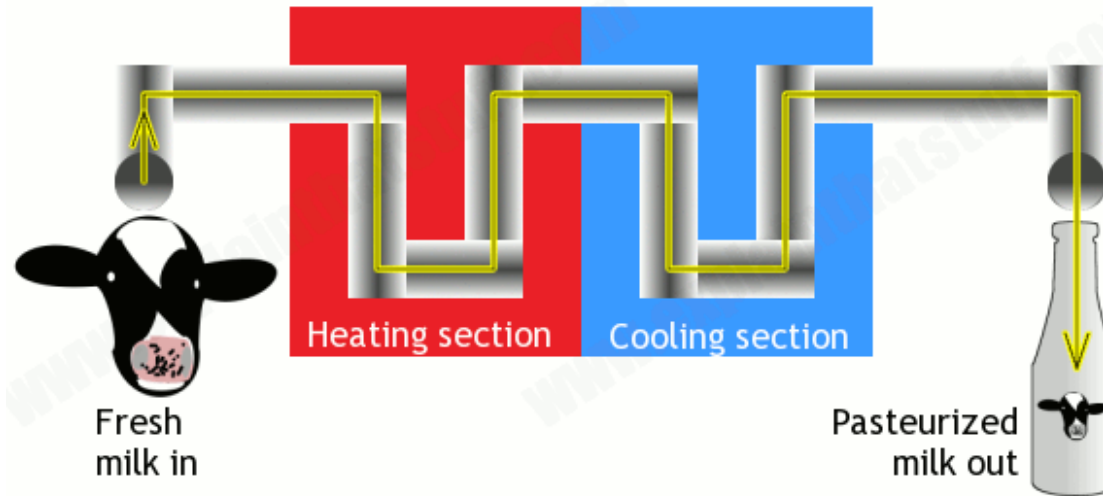
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18





HOW DOES A PASTEURIZER WORK?



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19



Thank you for your attention!

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**Video of the speaker
talking
(to be inserted)!!
(from 49:48)**

24-01-2018



20