Still Heating Technologies and Emulation of Direct Fired Character

James Ludford-Brooks

Briggs of Burton

BRIGGS

Talk Outline

- Introduction
  - Still heating objectives
- Overview of Still Heating Technologies
  - Direct Fired
  - Internally Heated
  - Externally Heated
- Emulation of Direct Fired Character
  - Can the Pot Still Heating Method Influence Spirit Character?
  - Investigation using Novel Thermal Fluid (Oil) Heating Technology

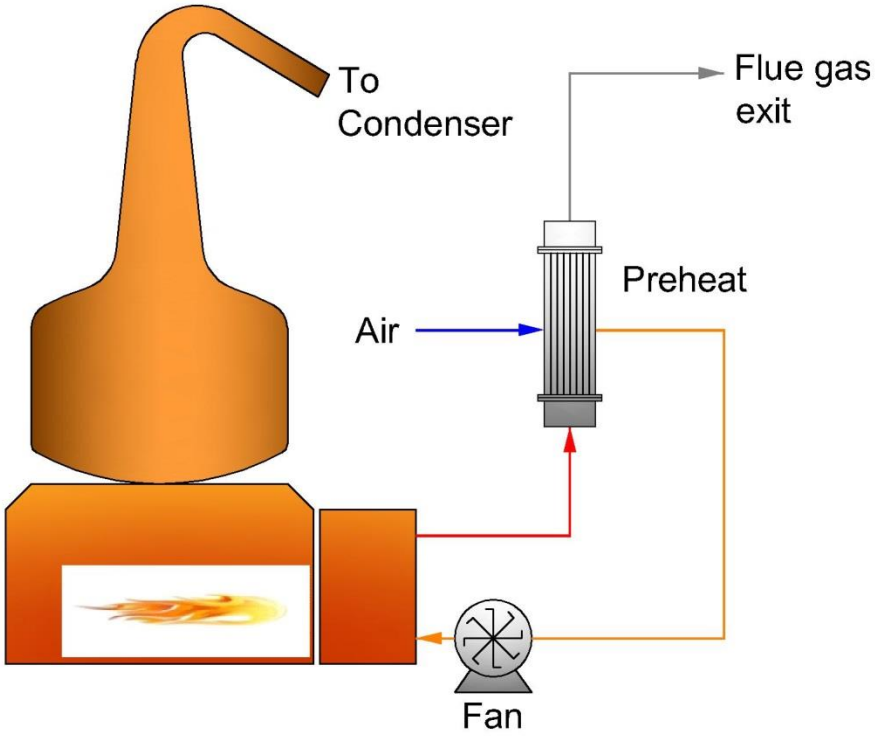
BRIGGS

Still Heating Objectives

- Heat the Still to boiling
- Maintain a consistent evaporation rate from Batch start to the end
- Minimise fouling & Cleaning
- Controllable, reliable & safe.
- Minimise energy usage / Carbon footprint

BRIGGS

Direct Fired System

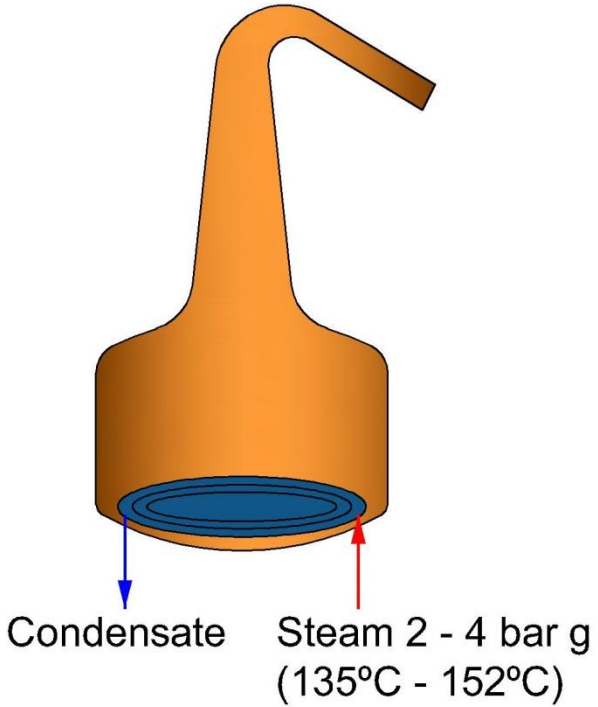


- Natural Gas Fired (typically) – flame temp 1200°C
- Flue Exit Temp 600°C
- Low Copper Surface Area > 200°C (~0.8 m^2/m^3)
- 9.2 kWh/litre pure alcohol (lpa)
- Preheated combustion air ~ 15% fuel saving
- Rummager – removal of fouling material produced continuously
- Refractory Lined ‘Hot Box’

BRIGGS

Internal Coil / Pans

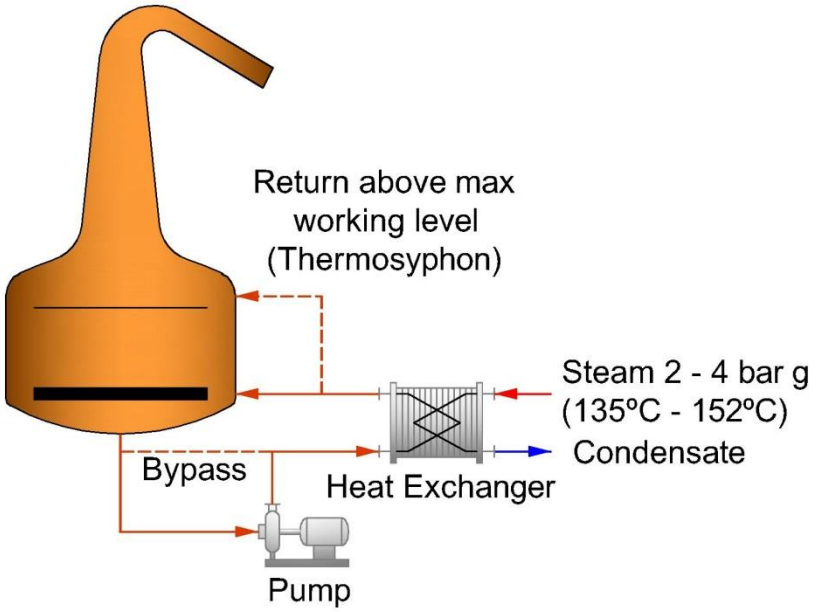
- Steam Most Common
  - Potential for Thermal Fluid
- Stainless Steel Coil / Pan
- Energy
  - Low Heating Surface Area
  - 135 - 152°C (0.8 m^2/m^3)
  - Typically Isothermal Heating
  - 7.2 kWh / litre pure alcohol (lpa)
- Cleaning
  - Fouling Removed by Cleaning In Place (CIP)



BRIGGS

External Heater (Plate or Shell & Tube)

- Wash does NOT boil in heat exchanger
- Min Height at End of Distillation is critical, Can dictate minimum Recirculation rate
- Check Net Positive Suction Head (NPSH)
- Heating Surface 135-152°C (1.0 m^2/m^3)
- TVR/HTHP High Heating Surface Area 95-107°C (~1.6 m^2/m^3)



BRIGGS

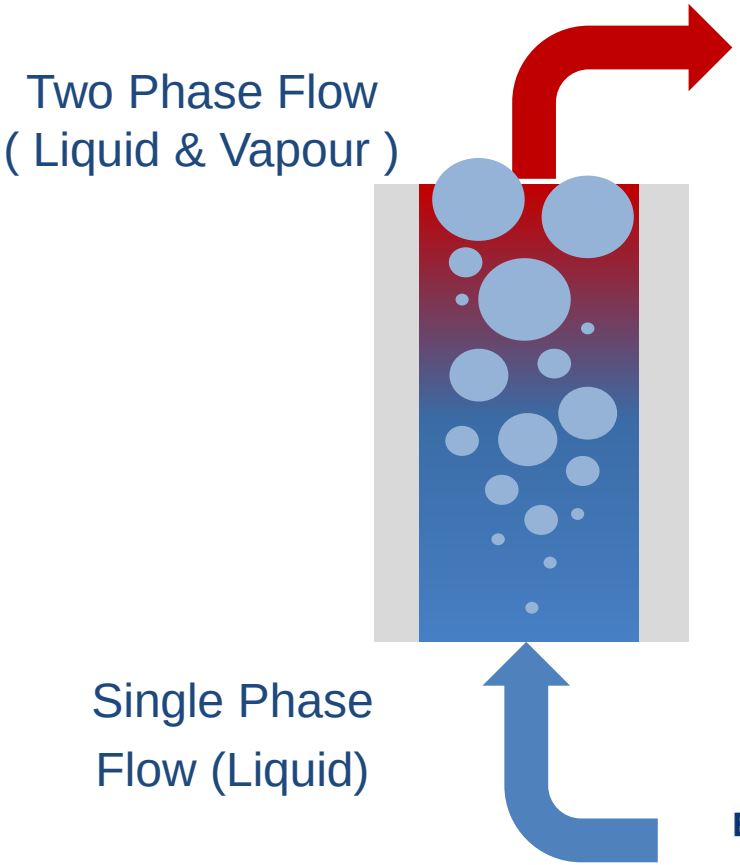
Pumped Recirculation - OPEX

- Recirculation pump operational cost often overlooked
  - ~ 0.3 -0.8 kWe/m^3
  - £2,400 – £5,900 cost p.a (per pump at 11p/kWh)
- Recirculation rate dependent on steam pressure and temp. raise per pass.
  - 6 - 15+ contents/hr.
- Thermosyphon during distillation could eliminate this cost
- Thermosyphon commonly used in brewing industry
- Vapour Bubbles Beneficial
  - Volatile Stripping
    - improved cogener recovery?

BRIGGS

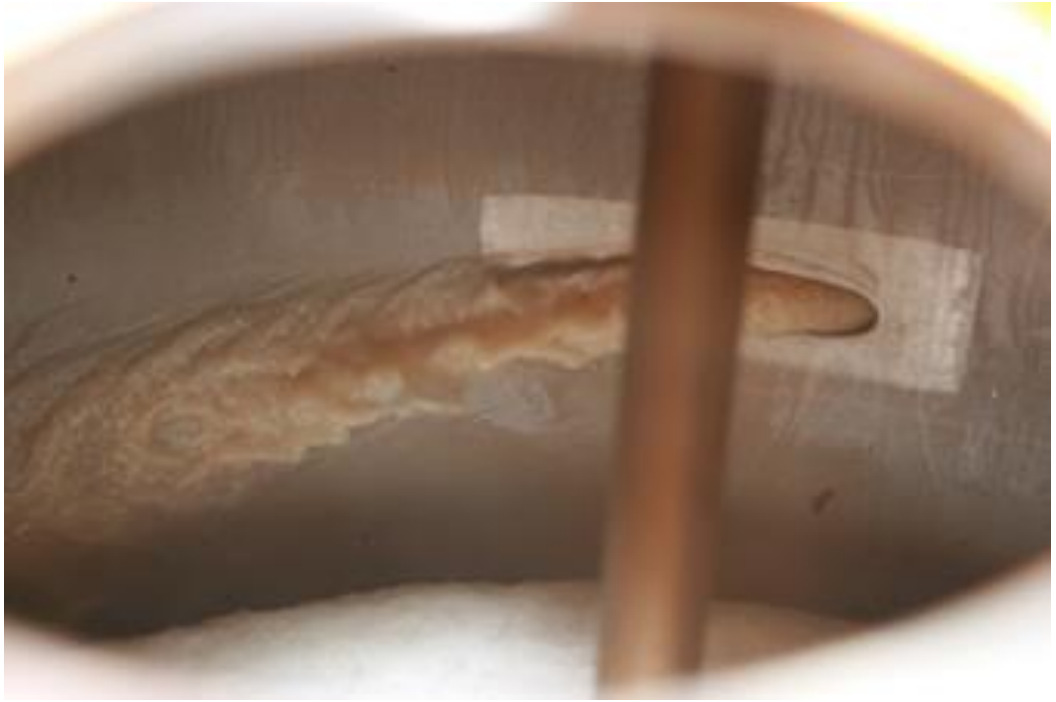
Thermosyphon Recirculation

- Principle:
  - Density difference between Single Phase and Two Phase system
  - Creates Driving Force for the Thermosyphon recirculation



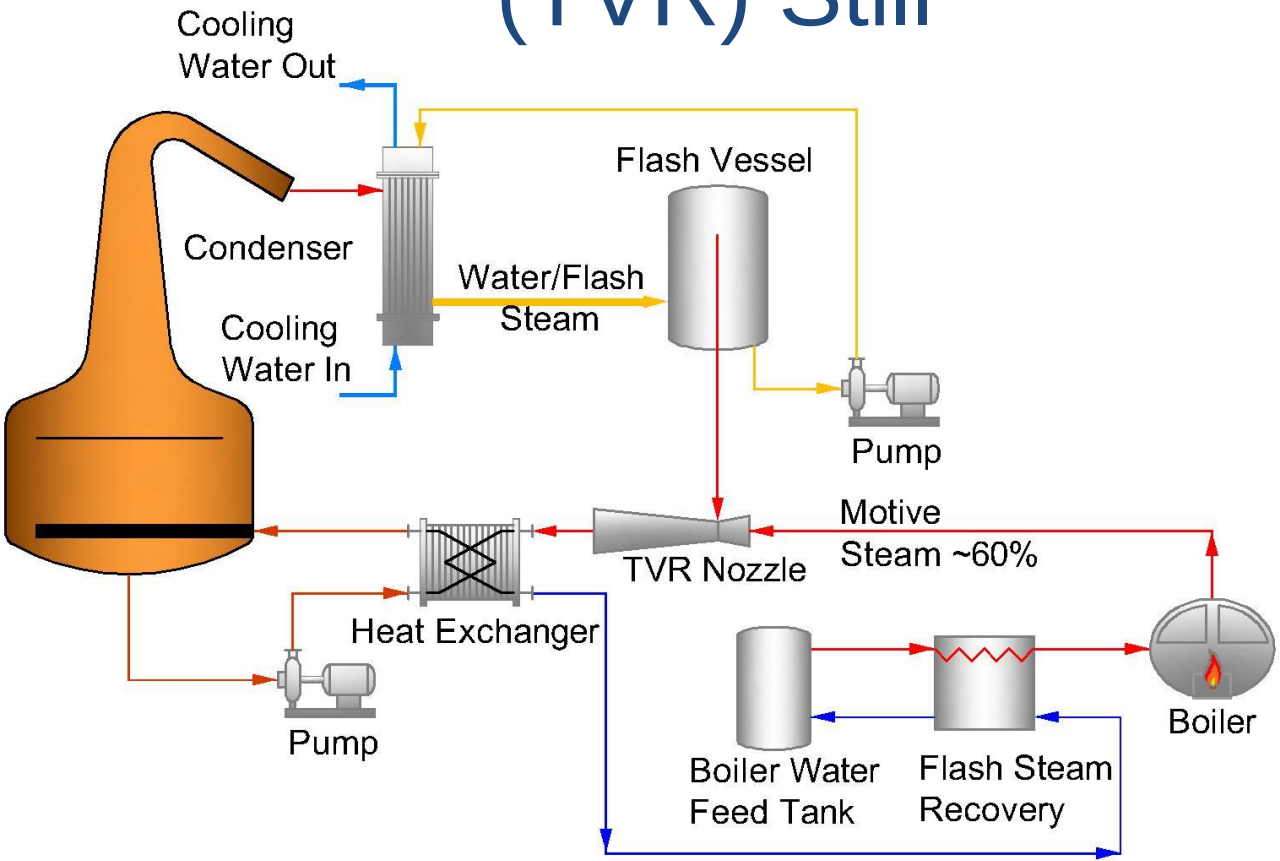
BRIGGS

External Heater – Return above max level



BRIGGS

Thermal Vapour Recompression (TVR) Still



BRIGGS

TVR Features

Pros

- 40% Reduction in Batch Distillation Steam Usage for Scotch Whisky Wash Distillation ~ 5.5 kWh/ l alc
- Low Steam Pressure, coupled with good control and **pumped condensate systems** yield consistent batch times and low fouling levels

Cons

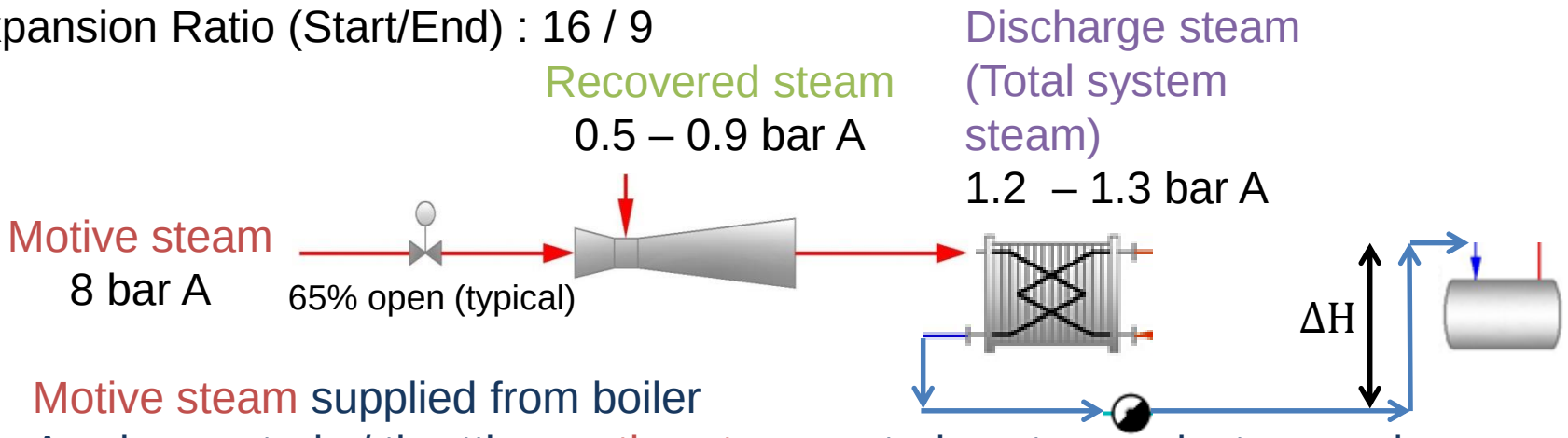
- Opex (Pump circulation)
- Generally complex operation (Automation & control)
- Condenser Life Reduced compared to traditional

BRIGGS

TVR Steam Injector Nozzle

Compression Ratio (Start/End) : 2.4 /1.4

Expansion Ratio (Start/End) : 16 / 9

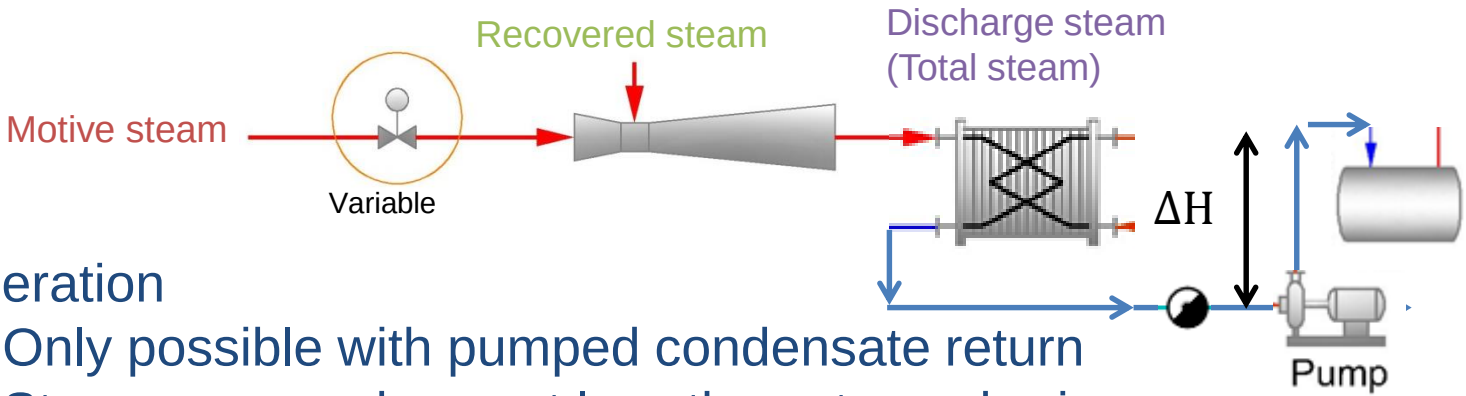


- Motive steam supplied from boiler
- A valve controls / throttles motive steam entering steam injector nozzle, steam required depends on compression ratio.
- Motive steam entrains the recovered steam
- Discharge steam heats the still and must be at sufficient pressure to push the condensate to drain/receiver

BRIGGS

TVR Operation – Variable steam supply

Compression Ratio (Start/End) : 1.8 /1.3
Expansion Ratio (Start/End) : 16 / 9

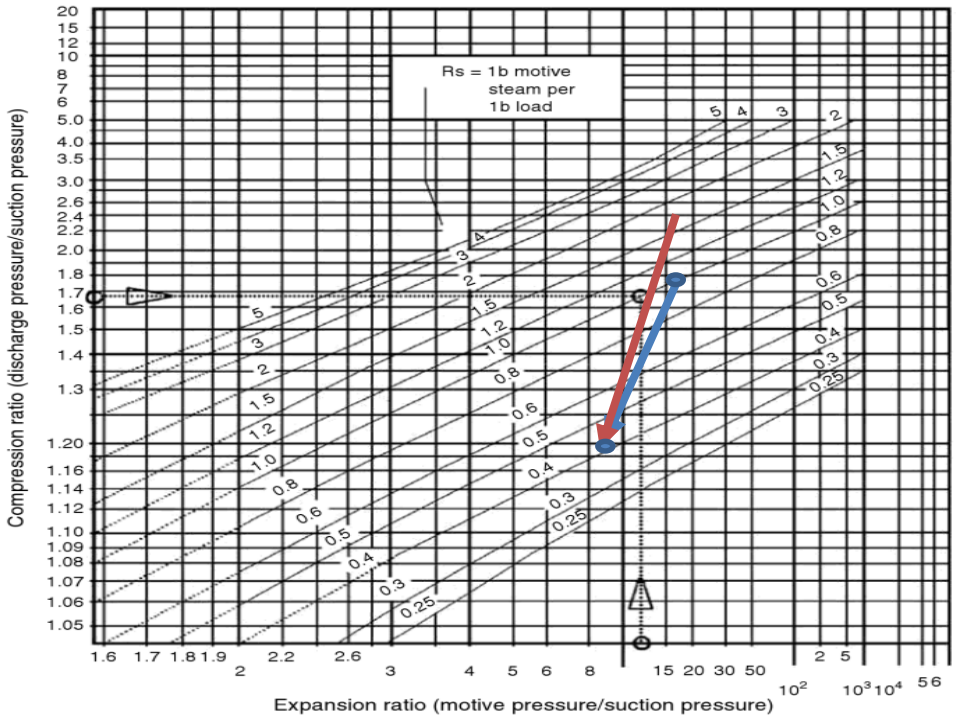


Operation

- Only possible with pumped condensate return
- Steam can condense at less than atmospheric pressure in the HX
- Motive steam is reduced as recovered steam increases

BRIGGS

Distillation steam recovery

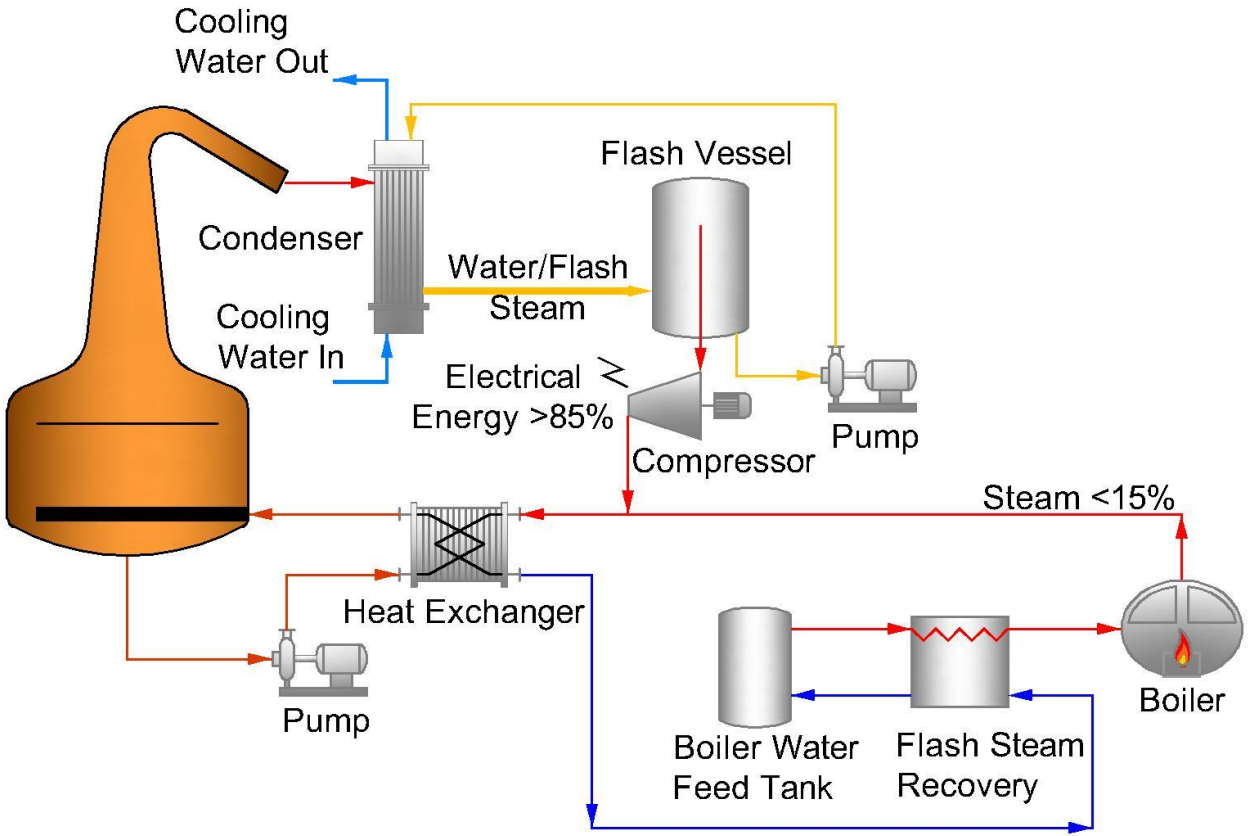


Theoretically:

- Fixed motive steam
  - 33 to 63 %
  - Avg. = 48 %
- Variable motive steam
  - 50 to 63 %
  - Avg. = **56 %**

BRIGGS

(HTHP) Still



BRIGGS

HTHP Features

Pros

- >85% Reduction in Batch Distillation Steam Usage for Scotch Whisky Wash Distillation
  - 3.3 kWh / litre alc
- Low Steam Pressure, coupled with good control and **pumped condensate systems** yield consistent batch times and low fouling levels
- Reliance on Fossil Fuel Significantly reduced

Cons

- No examples in existence
  - Briggs Auchroisk-1985
- Generally complicated operation
  - Automation & control
- Condenser Life Reduced compared to traditional
- Payback Relative to Boiler Fuel and Electricity Price
- Opex (Pump circulation)

BRIGGS

Emulation of Direct Fired Character

- Bently Heritage Distillery, Minden, Nevada
  - build a modern, safe and efficient still house
  - recreate the rich, delicate character found from direct fired stills

BRIGGS

Distillery Wash

Character obtained from Still
Influenced by

- Raw Materials & Yeast
- Wort Separation Method
- Degree/length of Fermentation
- Heating Method & Reflux

BRIGGS

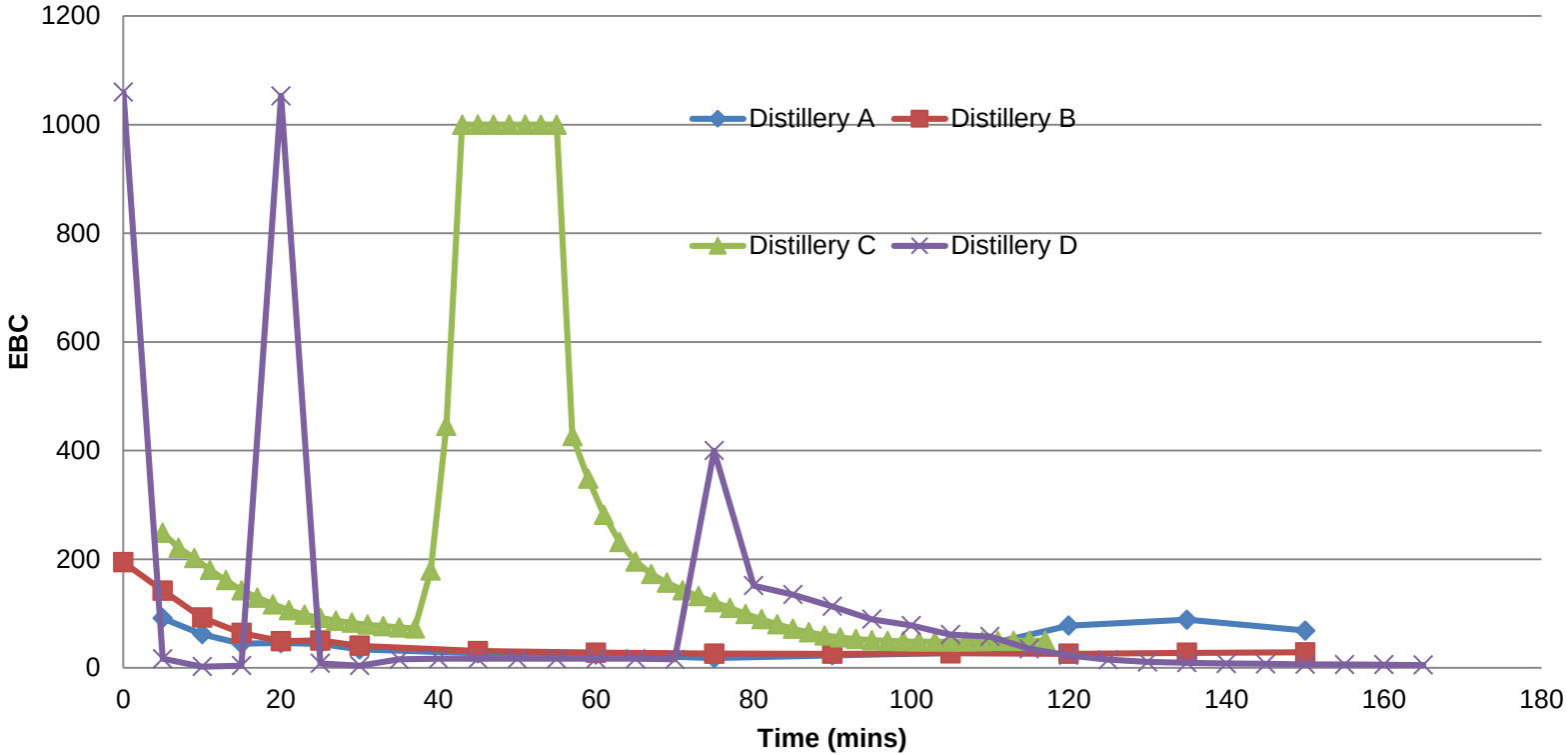
Maillard Reaction Temperatures

Flavour + colour =

- Water + (Temperature / Time) + (Amino acids + Sugar)

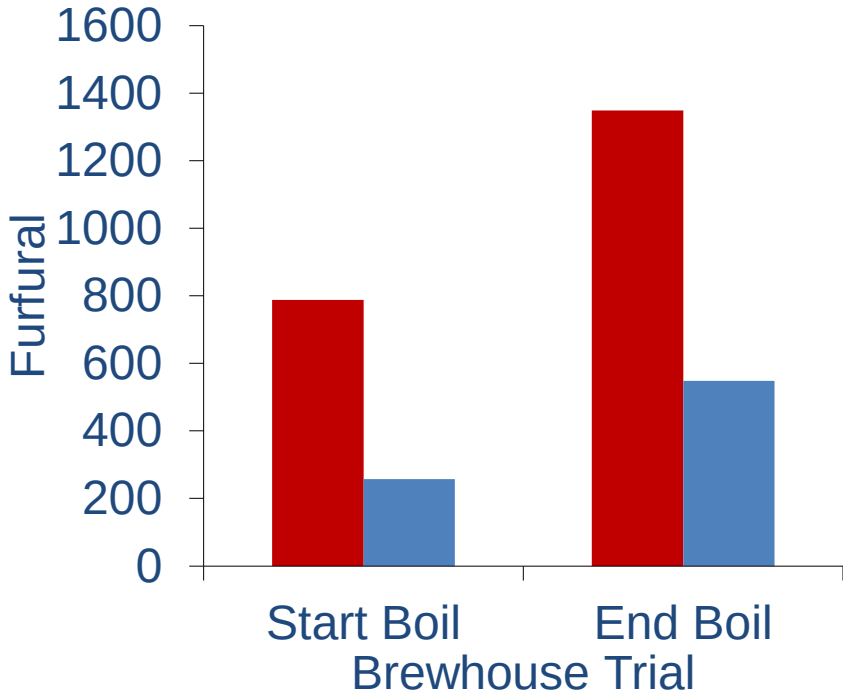
Still heating technology	TVR & HTHP	Steam	Thermal oil	Direct Fired
Operating temperature (°C)	107	135	185	>200

Wash Turbidity



BRIGGS

Furfural level – Effect of Higher Temperatures



- 830 hl 6.5% / h x 70 min boil:
- Internal Heater
  - High Temperature Surface
  - ~ 0.8 m^2/m^3
- High Surface Area Heater Low Temperature Surface
  - 2.2 m^2/m^3

BRIGGS

External Thermal Oil Heater

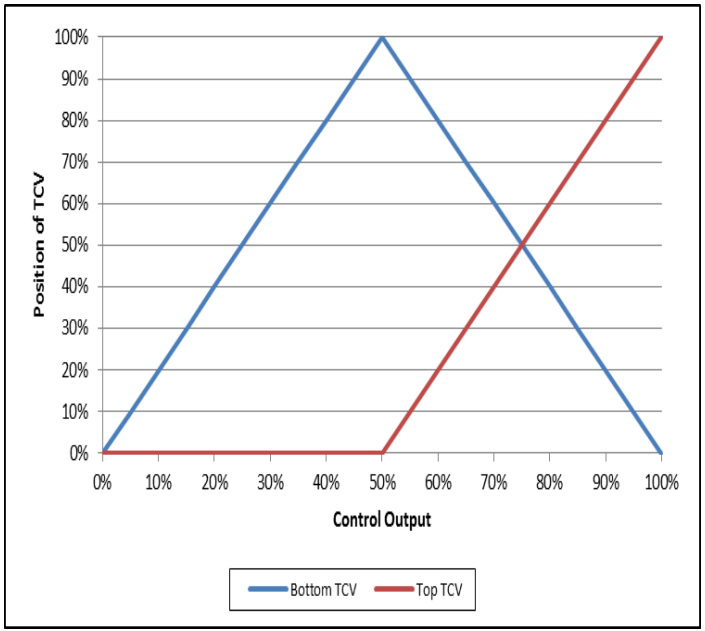
- Thermal Oil Heating - 200°C, low pressure
- Control By Variable Area (Unlike Steam, Which is Variable Pressure/Temperature)

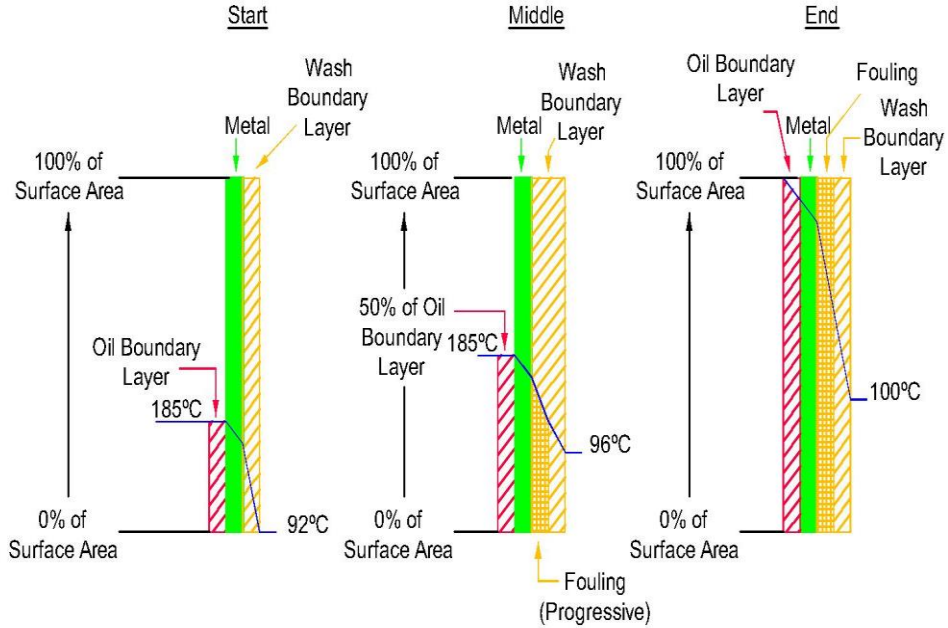
$$q = U.A.\Delta T$$

q = Heat Transfer (W) *[Rate of heat energy transfer per unit time]*
U = Overall Heat Transfer Coefficient (W/m².˚C)
A = Heat Transfer Surface Area (m²)
ΔT = Temperature Difference (˚C) *[Driving force]*

BRIGGS

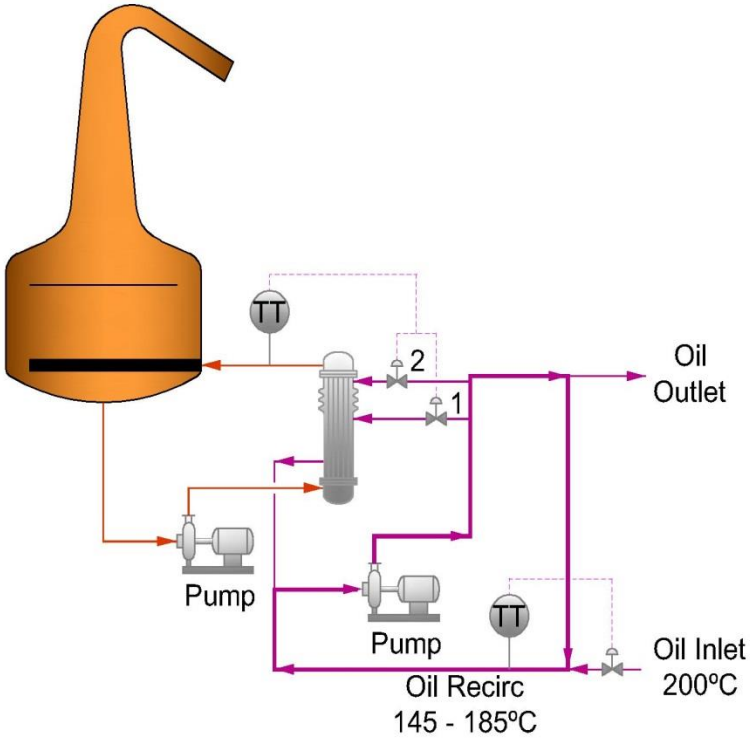
External Thermal Oil Heater





BRIGGS

External Thermal Oil Heater



- Forced Circulation - reduce Fouling, no boil at heat transfer surface
- Oil Recirculation maintained at desired Temp (145 – 185 °C)
- Split Range Control of HX Surface Area, lower valve (1) opens first, if duty not achieved, valve (2) opens
- Progressive fouling of heat exchanger Area ie Area increased as Heat exchanger fouls.
- Film boil likely to limit max temp of thermal oil in practise

BRIGGS

Summary

- Method of Still heating is an important choice
- Flexible equipment can allow the distiller to select for specific characteristics

BRIGGS

Thanks For Your Time

Connect With Us:

@BriggsofBurton

@WDSC2017

Contact Info:

UK office: +44 1283 566661

US Office: +1 585 426 2460

Website: www.briggsplc.co.uk

BRIGGS