Shell ConSep™ Tray Technology Provides Unparalleled Distillation Capacity

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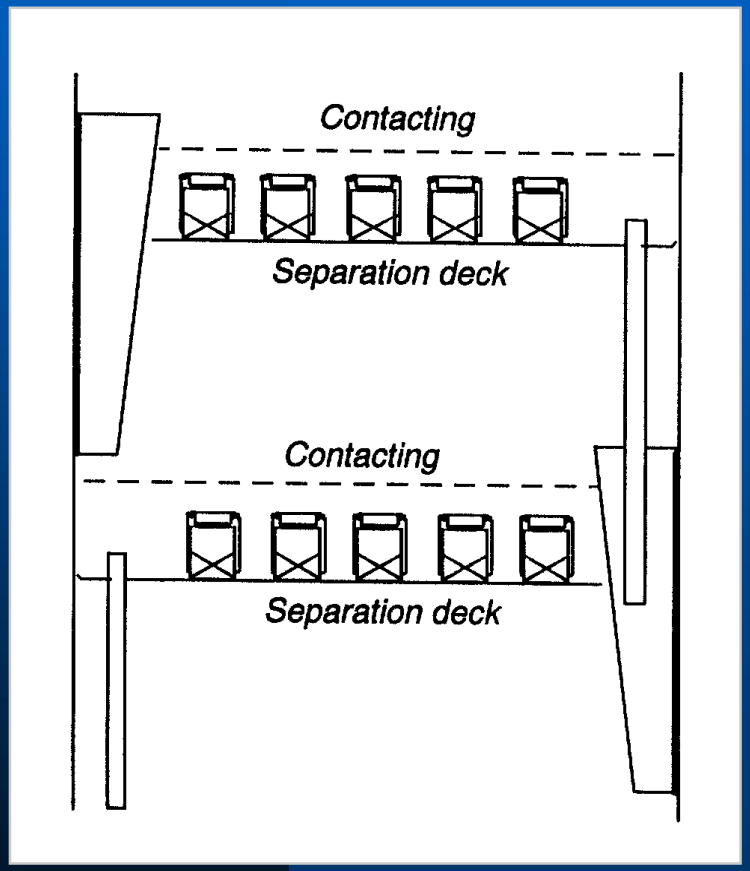
Shell ConSep™ tray
Principle & current applications



- **Combines features of contacting tray and centrifugal separator**
- Allows operation above floodpoint
- Tray efficiency and tray spacing comparable to conventional trays

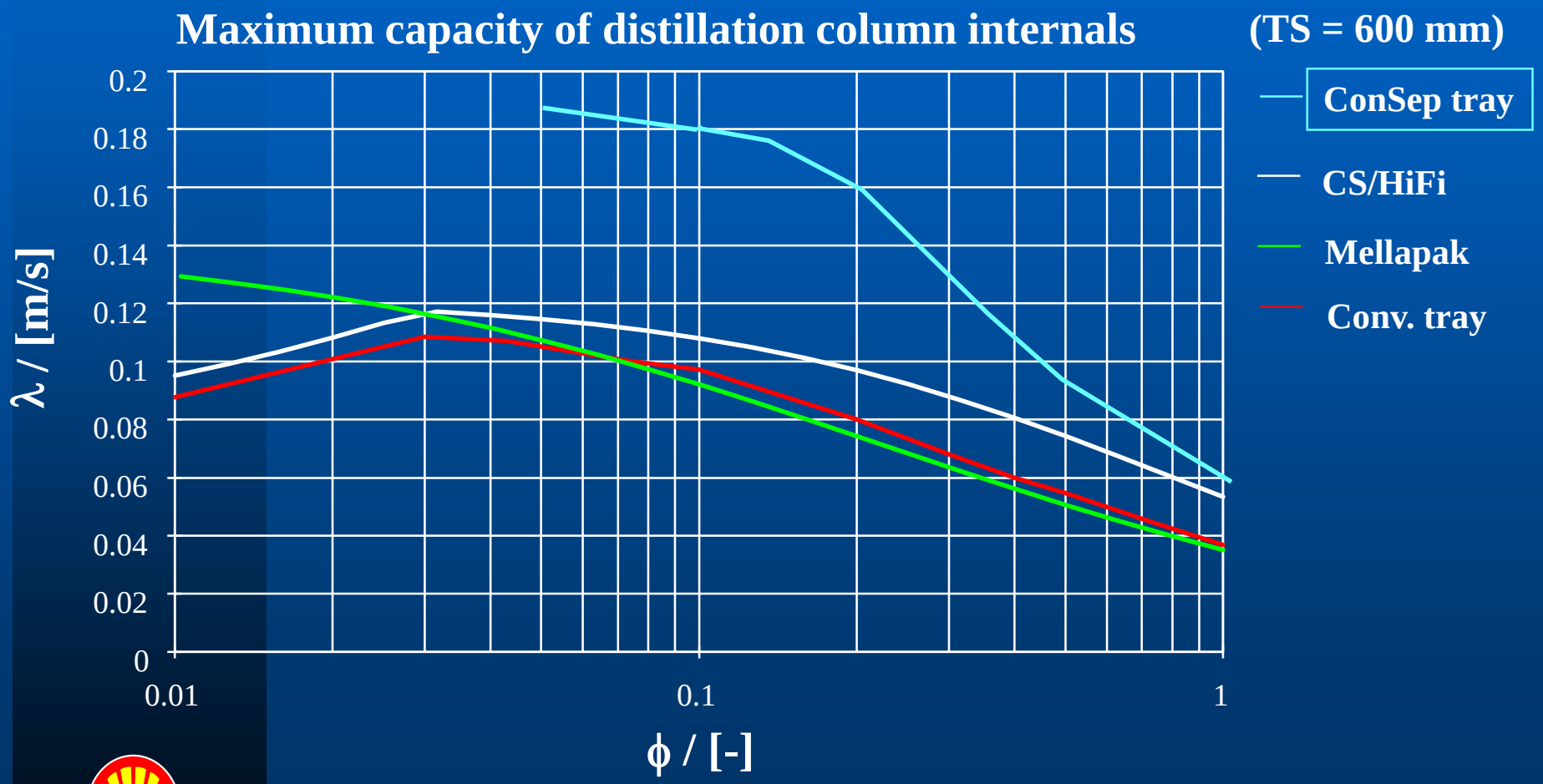
  450 mm < TS < 800 mm
- Inexpensive debottlenecking option for existing columns

Shell ConSep™ tray references

Country	Plant	Column diameter, m	Year	Max capacity increase achieved[1]
UK	NGL debutaniser	1.9	1995	23 %[2]
Australia	FCCU debutaniser	1.9	1996	30 %[3]
Germany	HCU main fractionator	2.2	1999	50 %
Australia	NGL debutaniser	1.7	1999	10 %[3]
Singapore	FCCU debutaniser	2.5	2000	-[4]

1. Post startup performance testrun - capacity achieved on top of the existing HiFi/CS trays.
2. Limited by reboiler duty.
3. Limited by other hardware constraints.
4. No test run data available.

Shell ConSep™ tray Capacity gain



Definitions

Column load factor

$$\lambda = \frac{V}{\rho_g A_c}\sqrt{\frac{\rho_g}{\rho_l - \rho_g}} \quad \text{(m/s)}$$

Flow parameter

$$\phi = \frac{L}{V}\sqrt{\frac{\rho_g}{\rho_l}} \quad \text{(-)}$$

Where

A_c = column cross section (m^2)

L,V = liquid, vapour flow rate (kg/s)

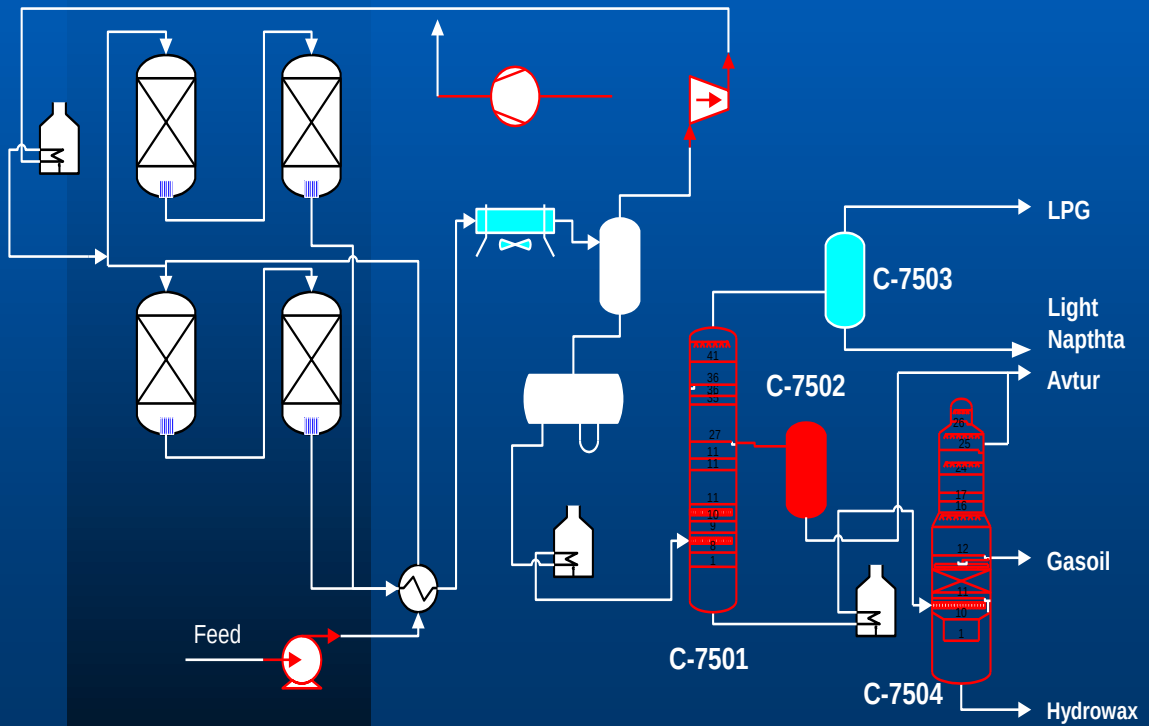
ρ_g, ρ_l = vapour, liquid density (kg/m^3)

Background of Godorf Hydrocracker

- **HCU originally designed / started up in 1983, feedrate 3000 t/d**
- **Revamped in 1989 to a capacity of 4500 t/d**
- **Throughput was further increased to 5700 t/d without any hardware changes**
- **Main bottleneck in the fractionation section**

Hydrocracker Revamp May 1999

Increase throughput from 5700 t/d to 6400 t/d



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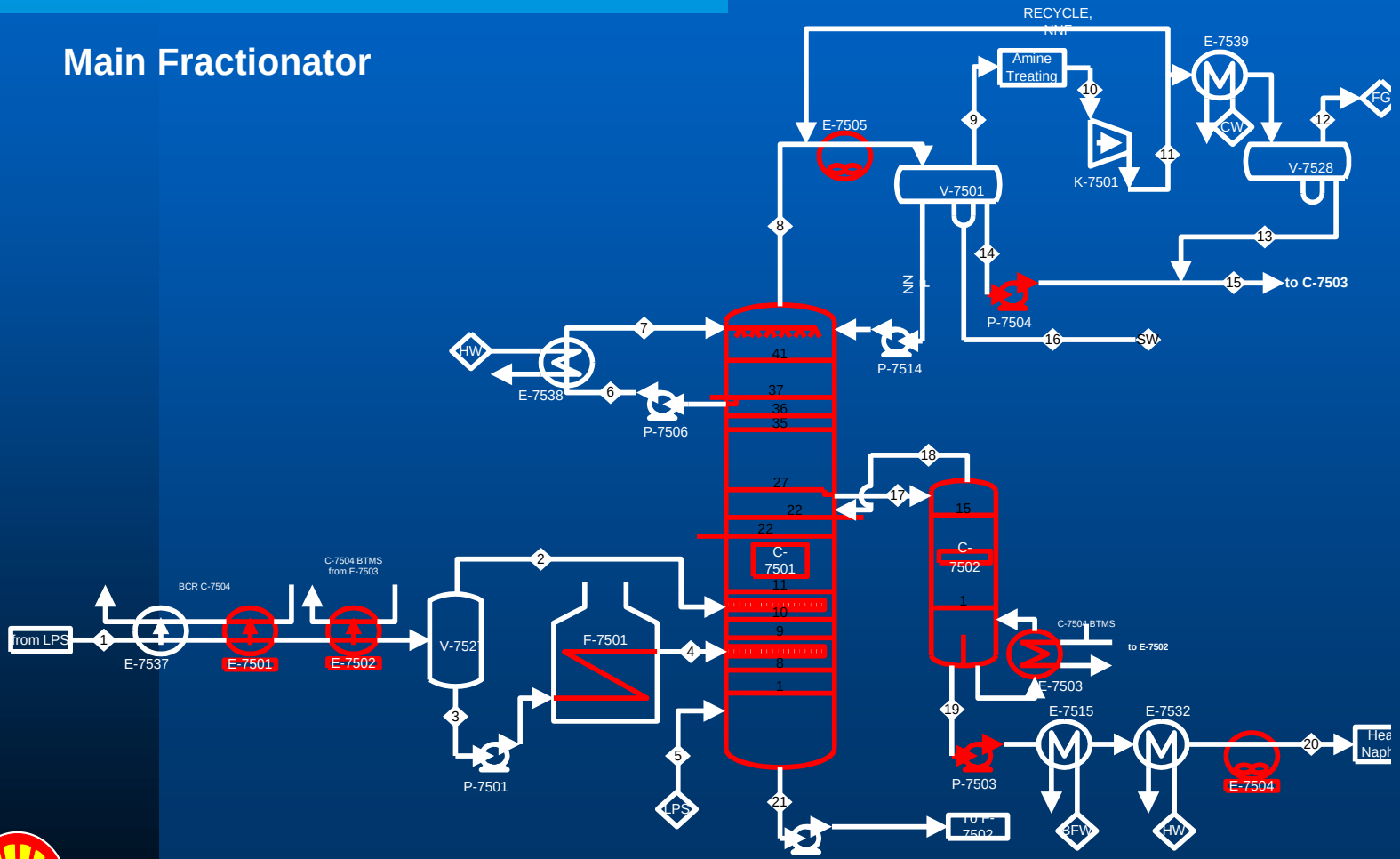
HCU Main Fractionator

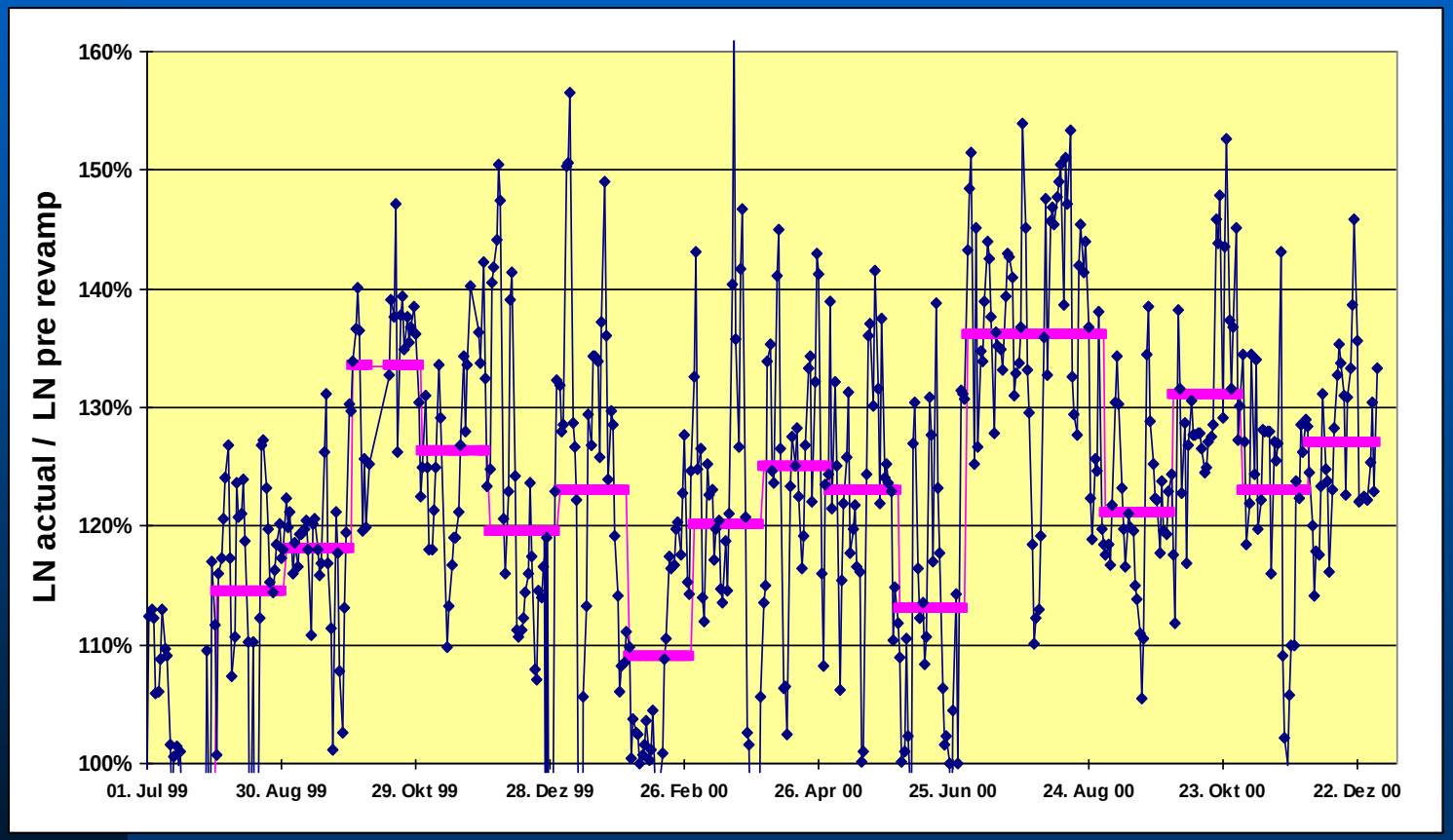
Main Fractionator



HCU Main Fractionator

- **Pre -revamp**
  - **Column was equipped with 41 CS / HiFi trays**
  - **Capacity was limited by flooding**
  - **max Light naphtha production was 900 t/d**
- **Revamp**
  - **all trays above feed replaced by ConSep trays**
  - **Installation of ConSep trays progressed without any major problems**
- **Post- revamp**
  - **Start-up went smooth, no difference in operating behaviour**

Increase in Light naphtha make
in comparison prior revamp



Conclusions

- **ConSep trays breakthrough in distillation tray technology**
- **HCU main frac third commercial application**
- **Tray capacity increase up to 50 % over previous CS trays has been proven with similar separation sharpness**