INTRODUCTION

• **Steam cracking:** Used to produce industrially important products such as ethylene, propylene and butadiene at high temperature (700 °C – 900 °C) in the presence of steam.

• **Transfer line heat exchanger (TLE):** The product stream of a steamcracker has to be cooled down using a transfer line heat exchanger (TLE) to contribute to the economics of an ethylene plant: more valuable products will obtained due to suppressing of secondary reactions and production of high pressure steam.

• **Heavy feeds:** Light olefins production from heavy hydrocarbon feedstocks is an economically promising concept, however operational problems due to fast coke formation in TLE can be extensive.

• **Main fouling mechanisms in the TLE:** Physical condensation and catalytic coke formation.

PROGRAM

Feed characterization

Obtaining an experimental dataset of feed coking tendencies in the TLE and in the reactor using the pilot steam cracker

Using experimental dataset to develop a coking model under TLE conditions

FEED CHARACTERIZATION

**Reason:** Coke formation mechanisms and tendencies are dependent on feed composition.

**Analytical methods:** Elemental CHNS analysis, GC x GC analysis with FID detector

**Light crude oil feedstocks:** Compositions of three light crude oils with different pretreatment procedures are compared:
- Distilled crude
- Hydrotreated crude
- Distilled hydrotreated crude

**Elemental CHNS analysis:**
- Detector: TCD
- Injection method: Liquid sample in hard tin cups
- Internal standard for calibration curve: BBOT

**Composition BBOT:** 72.53 wt% C, 6.09 wt% H, 6.51 wt% N, 7.44 wt% S, 7.43 wt% O

**GC x GC analysis:**
- Detector: FID
- Internal standard: 3-chlorothiophene or bromobenzene
- Modulation: 7 sec; using liquid CO₂
- PINA analysis: indicating wt% paraffins, isoparaffins, naphthenes and aromatics

**EXPERIMENTAL WORK**

Pilot steamcracker experiments

• Heavy Feedstocks
  • Product yields will be examined online using:
    1. GC x GC (FID)
    2. RGA (TCD and FID)
  • Coke formed during cracking will be determined by measuring CO/CO₂ concentration in the effluent during decoking (IR detector)

MODELING

Developing a coking model that relates:

• The composition of the feedstock using the analytical methods
• Results obtained using pilot steamcracker experiments

CONCLUSIONS + FUTURE WORK

• Each feedstock has a slightly different composition which will have an effect on product yields and coke formation tendency.
• This effect will be examined using pilot steamcracker experiments under different operating conditions.
• In order to completely determine the composition of the feedstock and pyrolysis fuel oil, LC x GC should be used next to GC x GC.
• LC x LC: Possible to separate higher boiling components, particular polycyclic aromatic hydrocarbons