# Oxidation of Ethylbenzene in a milli-meter G-L Taylor flow reactor

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## Background

***Structured reactors and energy saving***

- In the Netherlands, Chemical & Refining Industry uses 40% of the total primary energy consumption with partial oxidation processes as large energy consumers.
- Structured reactors with Taylor flow (TF) (Fig. 2) have improved heat and mass transfer, enabling high selectivity and conversion
- Energy savings is possible because of decreasing of energy consumption down stream

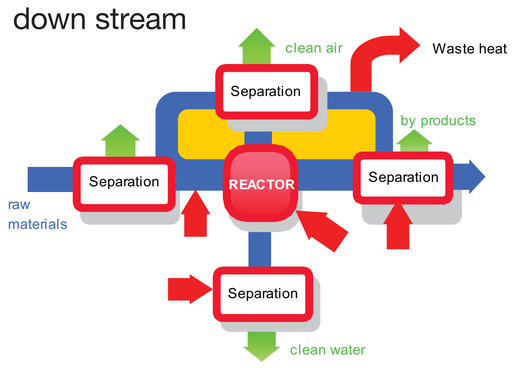



Figure 1: Energy usage in process industry


Figure 2: Taylor flow

## Partial oxidation kinetics

Autocatalytic oxidation [2]

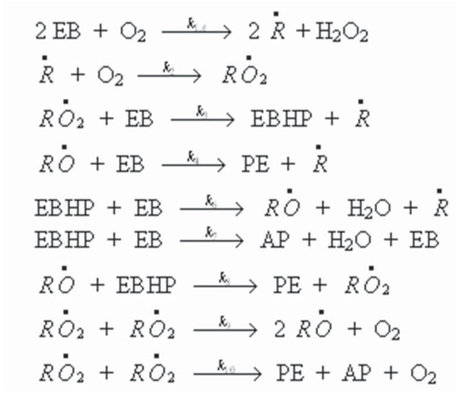



Figure 3: Model reaction for Ethylbenzene oxidation [1]

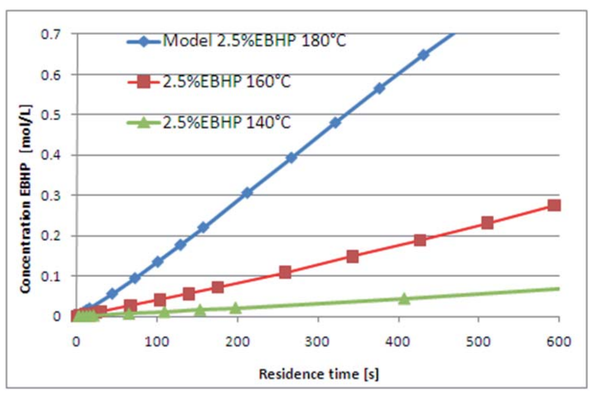



Figure 4: Operating window for temperature range 140 -180 °C

## Flow Pattern map

Water-air (ambient)

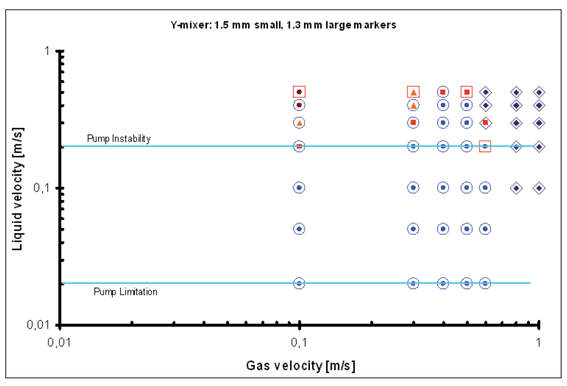



Figure 5: Operating window for fluid flow range: VG < 0.6 m/s, VL< 0.2 m/s

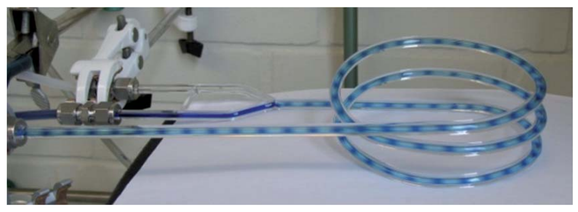


Figure 6: Hydrodynamic set-up

## Objective

- Demonstrating the strength of Taylor flow reactors in improving the selectivity in G-L reactions
- Develop and build a milli meter Taylor flow reactor equipment (mm TFR)
- Performing autocatalytic oxidation of ethylbenzene with pure ox

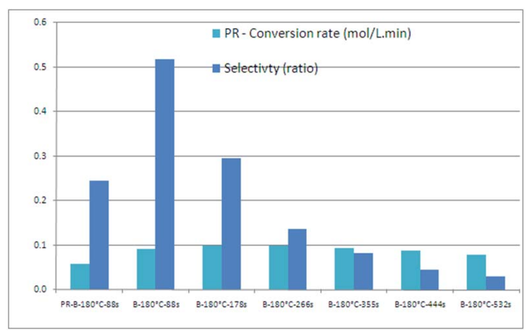
## Structure of the project

- Conceptual design → safety analysis →P&ID →Building the mm TFR equipment
- Extended experimental programme on autocatalytic reaction.
  - ✓ Kinetic modelling to support building experimental matrix
  - ✓ Hydrodynamic experiments to define Taylor flow conditions
  - ✓ Performing oxidation experiments

## Results


Scope
T = 300 C
P = 40 bar
$F_L$ = 100 $ml_n$/min
$F_G$ = 200 $ml_n$/min

Figure 7: Taylor flow reactor installation build at ECN



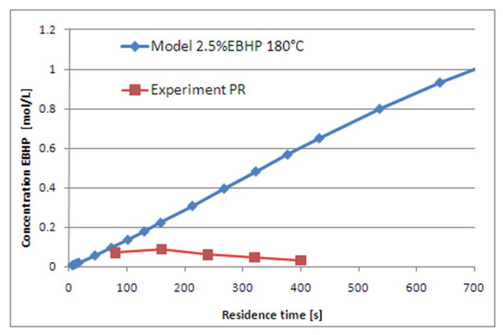




Figure 8: Conversion and selectivity at 180 °C compared with results of kinetic model

## Conclusions

- Oxidation with pure oxygen can be performed safely in mm ECN TFR
- EBHP production is feasible and the results are in agreement with the model
- Prolonged processing leads to increased decomposition

## Future work

Optimize process conditions and reactor specifications to eliminate increased decomposition

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