FISCHER-TROPSCH PRODUCTS FROM COMPACT REACTOR AND HIGH-TEMPERATURE IRON CATALYST

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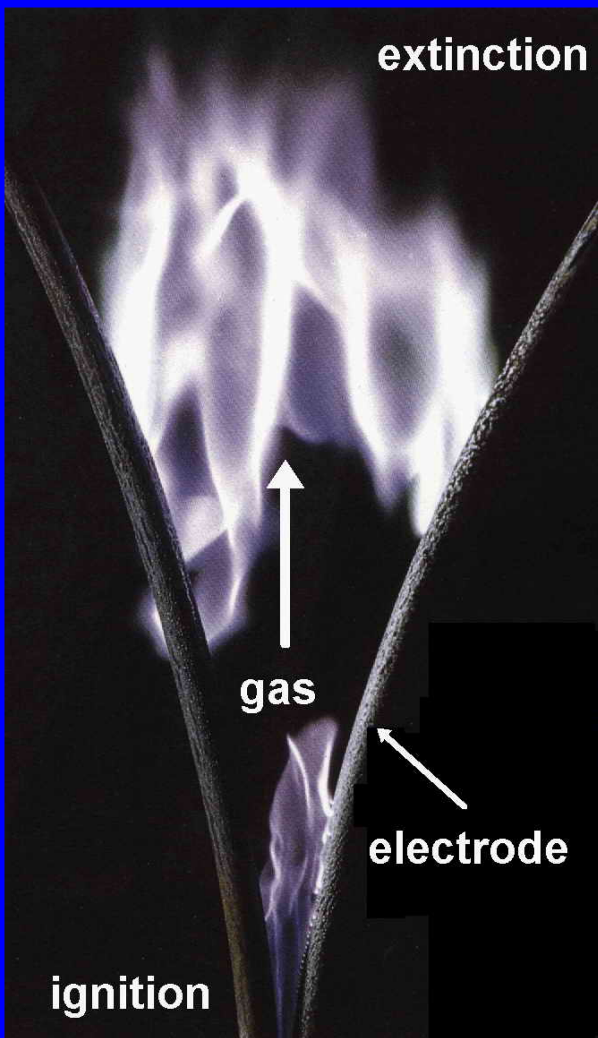
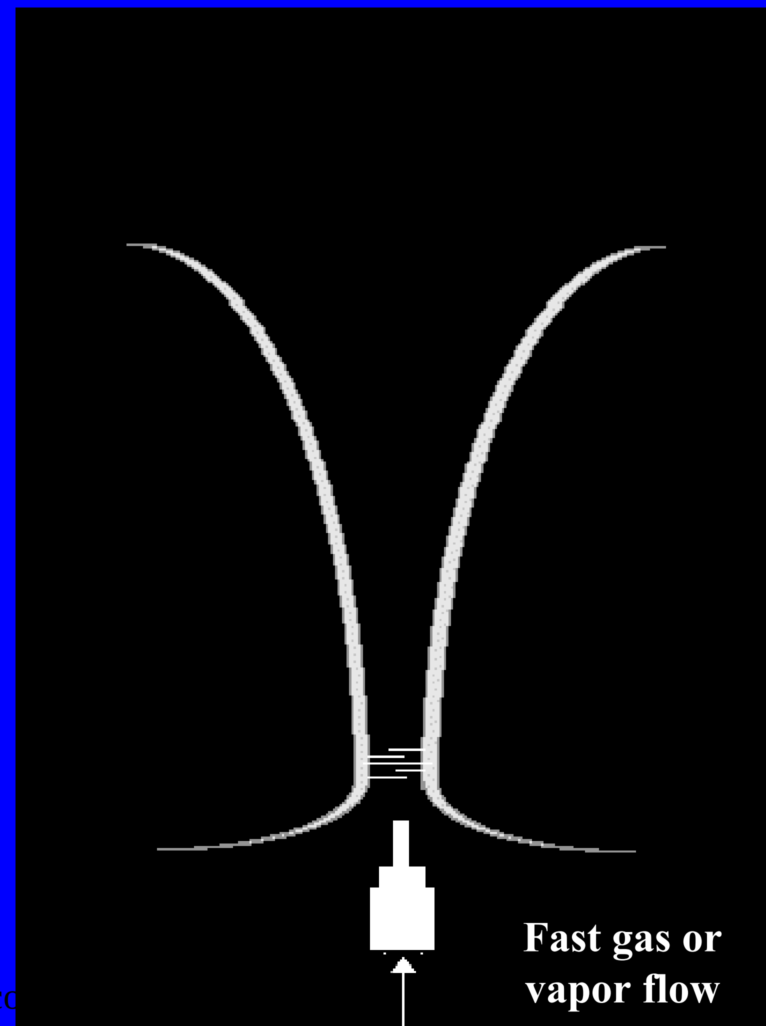
ECP – GlidArc Technologies, France

ECP has been developing plasma devices starting (1959) with a free burning arc (1500 A)… Presently we are at the stage of very efficient Gliding Arcs





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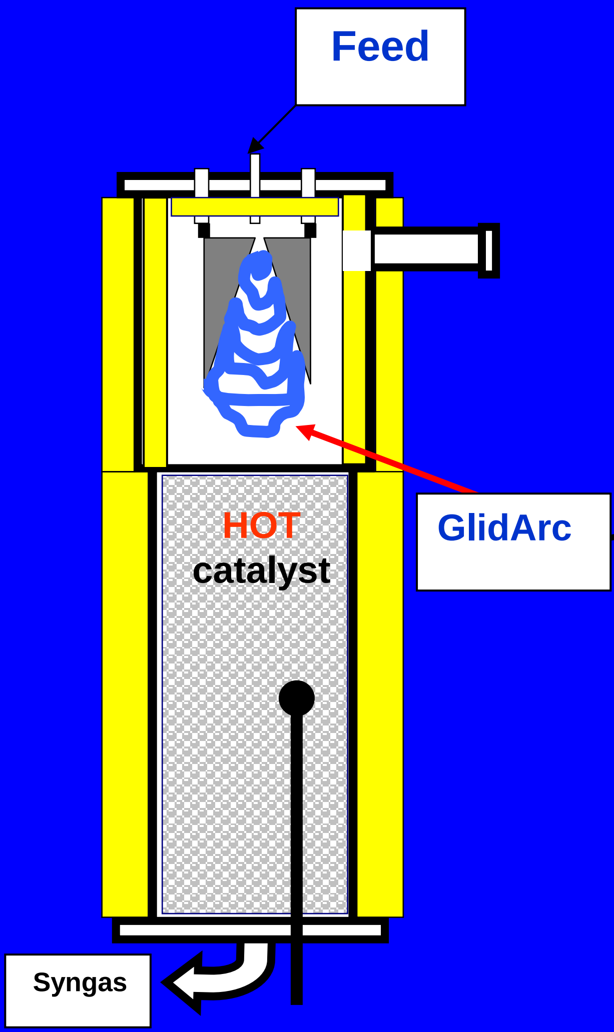
GlidArc devices have been applied to build new Plasma Reactors and test new Processes



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Availability of "Green" feeds

that we can easily convert into clean Syngas:

Bio-Methane from anaerobic digestion of almost any biomass or organic waste (relatively small scale but in numerous local sources)

CO_2 + H_2S (acid gas) from biogas cleaning

Waste organic liquids

Glycerol, Bone Oil, animal fat, wood oils, …

Waste organic solids (like wood, straw, plastics, MSW, etc.) that can be gasified or pyrolyzed into a crude fuel gas or liquid - for further reforming into a clean Syngas

see our poster tonight

…

Opportunities for use of small distributed Syngas production →

=> Synthesize clean liquid fuels!

Five challenges:

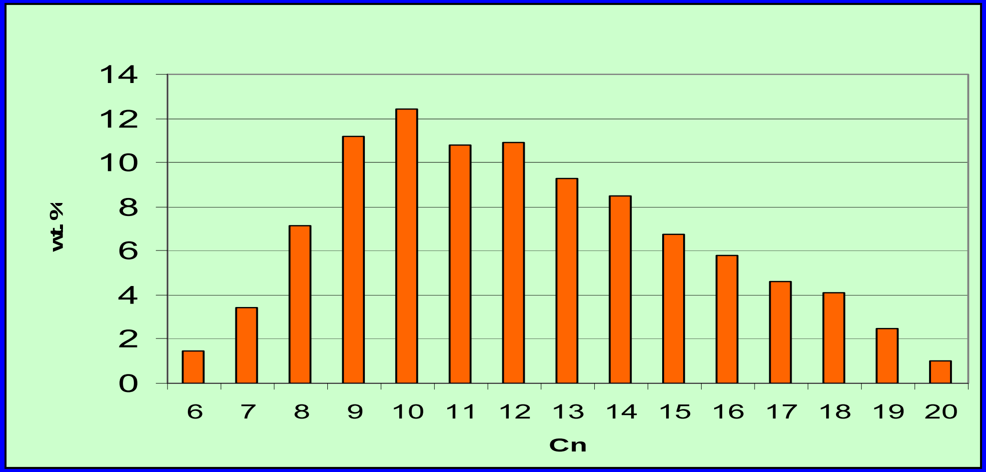
1) small scale clean Syngas generation
2) small synfuel plant
3) tailored catalyst
4) advanced product processing
5) advanced plant management

1957: we met the synfuel plant in Poland

1992: we came back to the process synthesizing such fuel in France (bench scale)

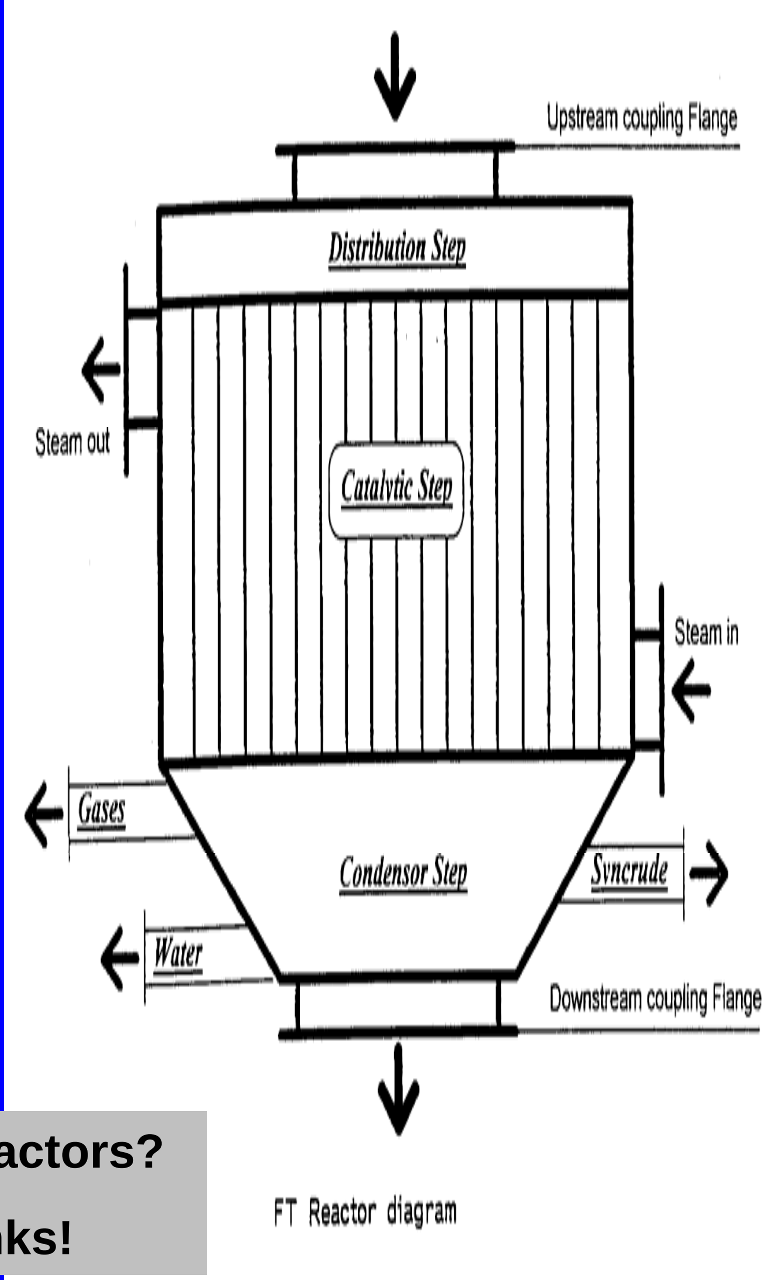
1999: we built a 1-L fixed-bed reactor supporting 20 bar and we tested some Cobalt catalysts; it was the biggest French synfuel reactor those time!

1-inch 4.8 m steel tube (oil-cooled)



Our choice: Low-Tech based on

- **Fixed bed reactor**
- **Iron-based catalyst**
- **Centralized services**



This type reactors?

No, thanks!

Or such a one?

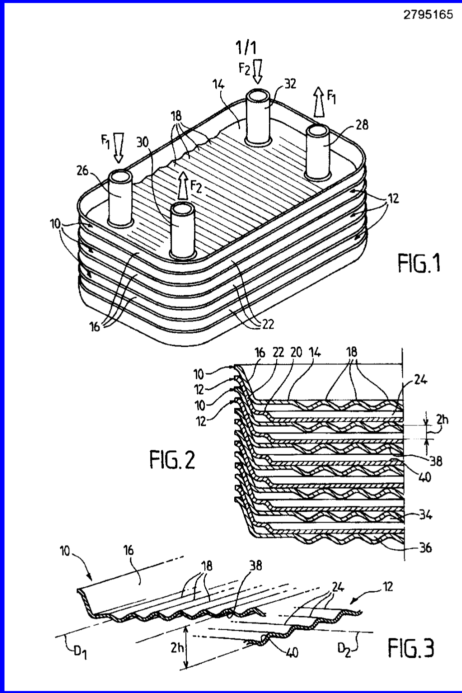
From the Statoil web page:

The reactor was fabricated by IHI (Ishikawajima-Harma Heavy Industries Co., Japan) and was erected in July 2003. The reactor diameter is 2.7 metres, the overall height of the structure is about 40 metres, and the plant's footprint is 30 by 30 metres when all of the auxiliary equipment is included (heat exchangers, separators etc.). Construction was completed in March 2004 at a total cost of USD 50 million.

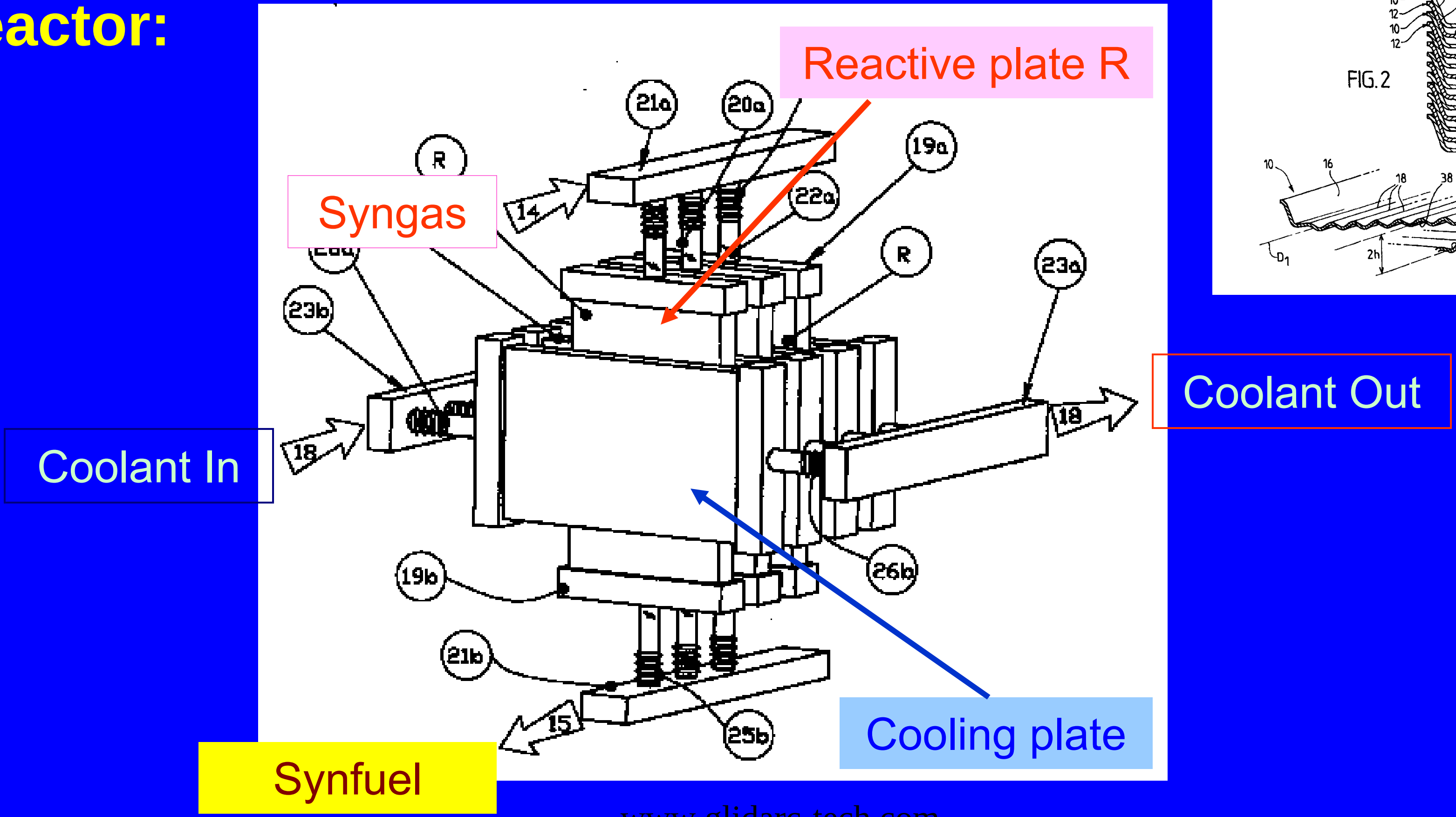
No, thanks!

9 years ago ECP finally put together our 53-years experience & dreams

based on common heat exchanger design like this →



we patented a **multiple-plate (sandwich) reactor:**



a) Good heat removal → reactor size reduction →

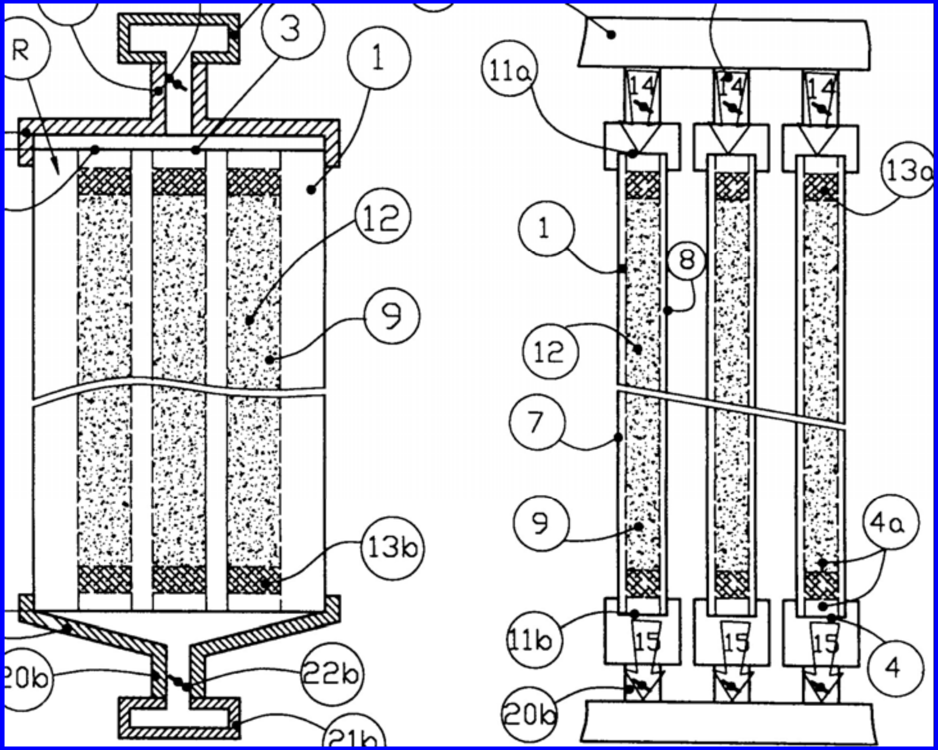
b) Reactor is easy to ship, assemble and disassemble →

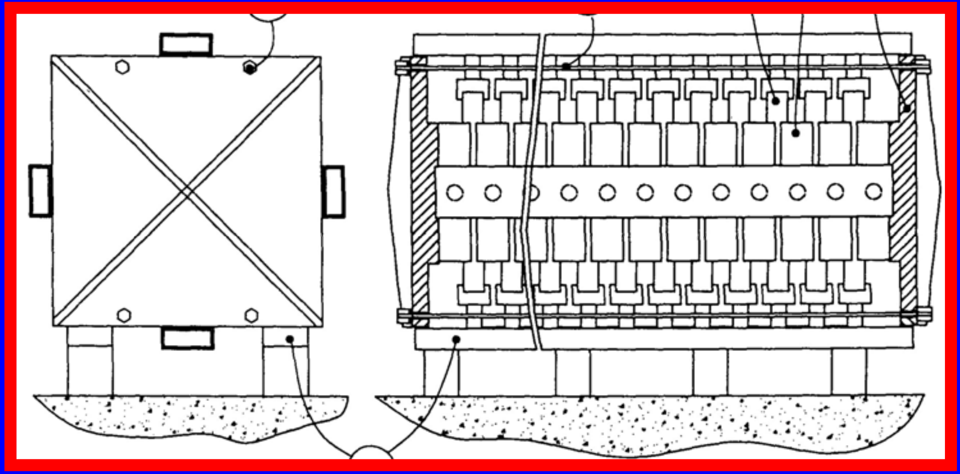
c) Acceptance of a frequent catalyst exchange → cheap and friendly Iron catalyst →

d) Catalyst activation can be done in a separate site → ready-to-use R plates can be shipped to the final user for a simple exchange and return of deactivated R plates for regeneration →

e) Protection of know-how on the catalyst formulation, preparation, reduction, and <u>activation</u>

f) Paired with our GlidArc reforming technology to open small distributed markets





Good heat removal alows not only the reactor size reduction but also:

Avoidance of a direct steam cooling →

Access to higher temperatures →

250°C → 350°C
40 bar→ 160 bar

Use of simpler catalysts boosted *via* temperature increase

Higher Carnot's Heat-to-Power efficiency

250°C → 350°C increases by 3.3 times the process kinetics

→ to keep the same kinetics one can therefore reduce the catalyst activity by factor of 3.3 (optional)

250°C → 350°C increases by 20% the theoretical efficiency of power generation using byproduct heat from synfuel reactor cooling

… first real elements

Ø 14mm
0.16 L

Ø20mm
0.58 L

3-tubes
Ø 20mm 2L

8-tubes, ø20mm, 5.5 L

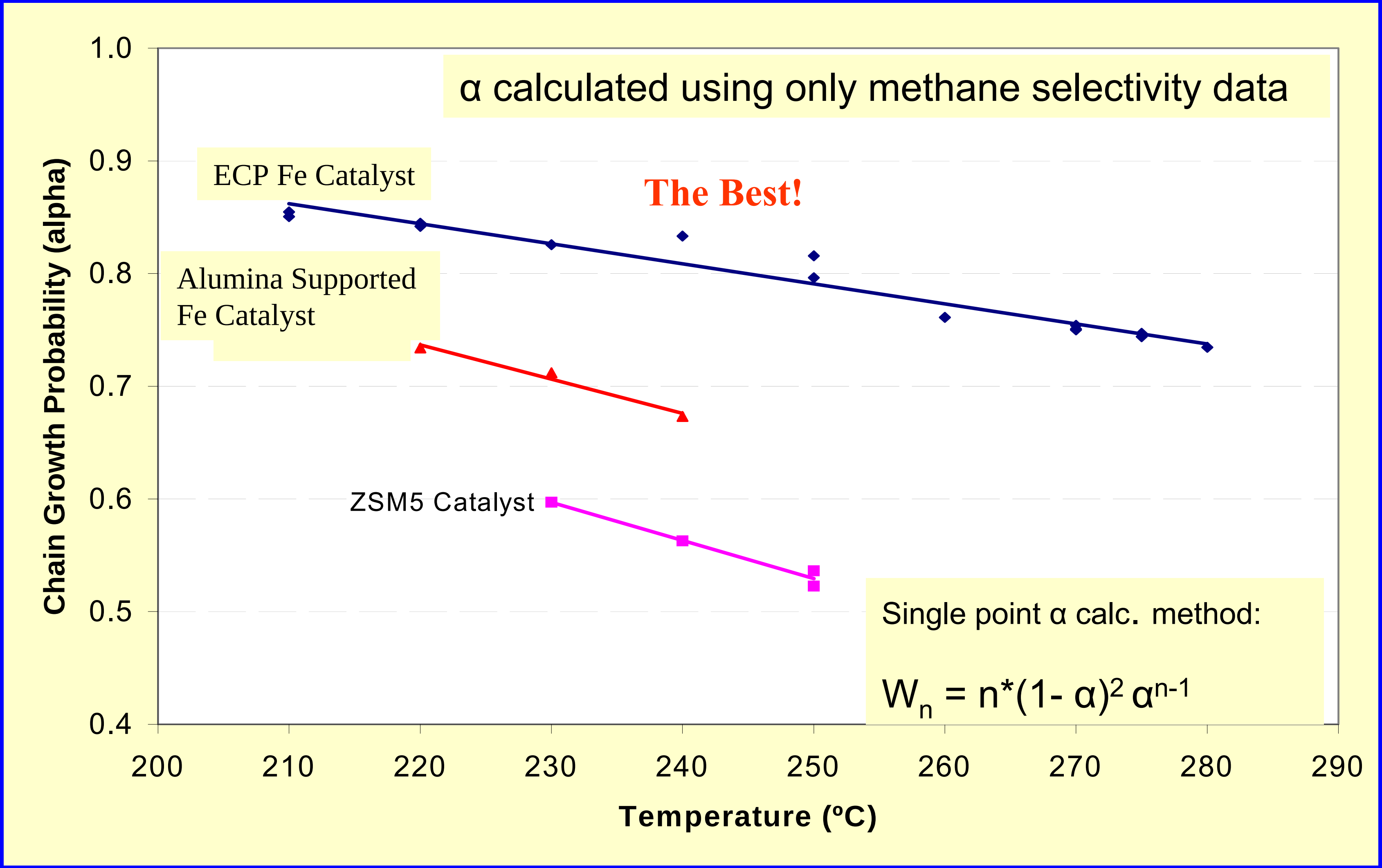
SynGas compressor (200 bar)

Ø 60mm 6.4 L

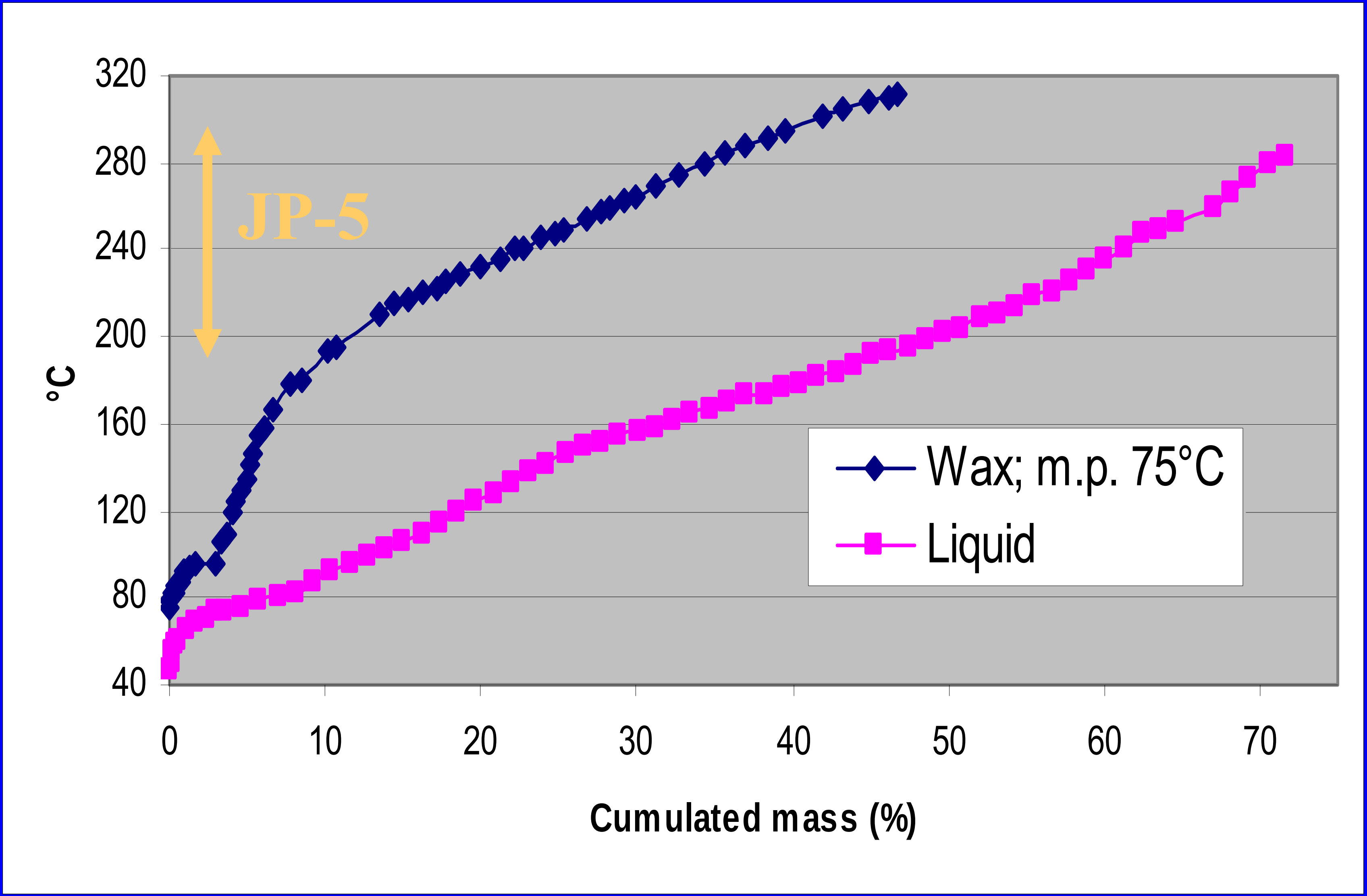
Reactor Validation Testing @ various:

- **Tube diameters (14 - 60 mm) and height (1.4 - 4.8 m)**
- **Iron-based catalysts (ECP)**
- **Catalyst supports (including some unconventional)**
- **Catalyst reduction & activation procedures/conditions**
- **Process Temperatures & Pressures**
- **Real syngas compositions, not just bottled gas blends**
- **Locations** (France, Sweden, Utah, Norway, Florida)
- **Etc.**

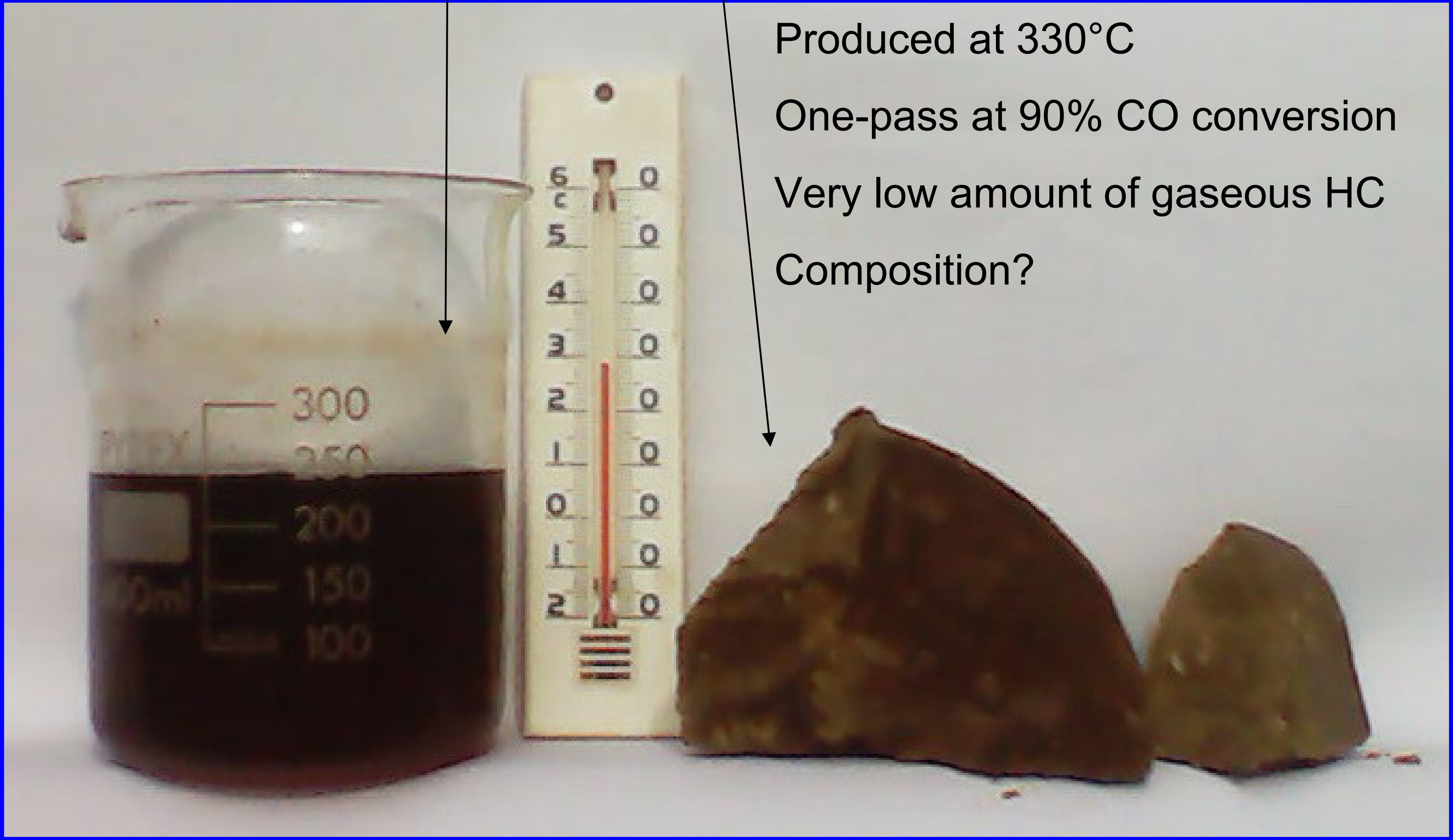
Comparison of catalyst Alpha curves



Distillation curves of some ECP products (100-g sample)



Our typical "water" and Wax products

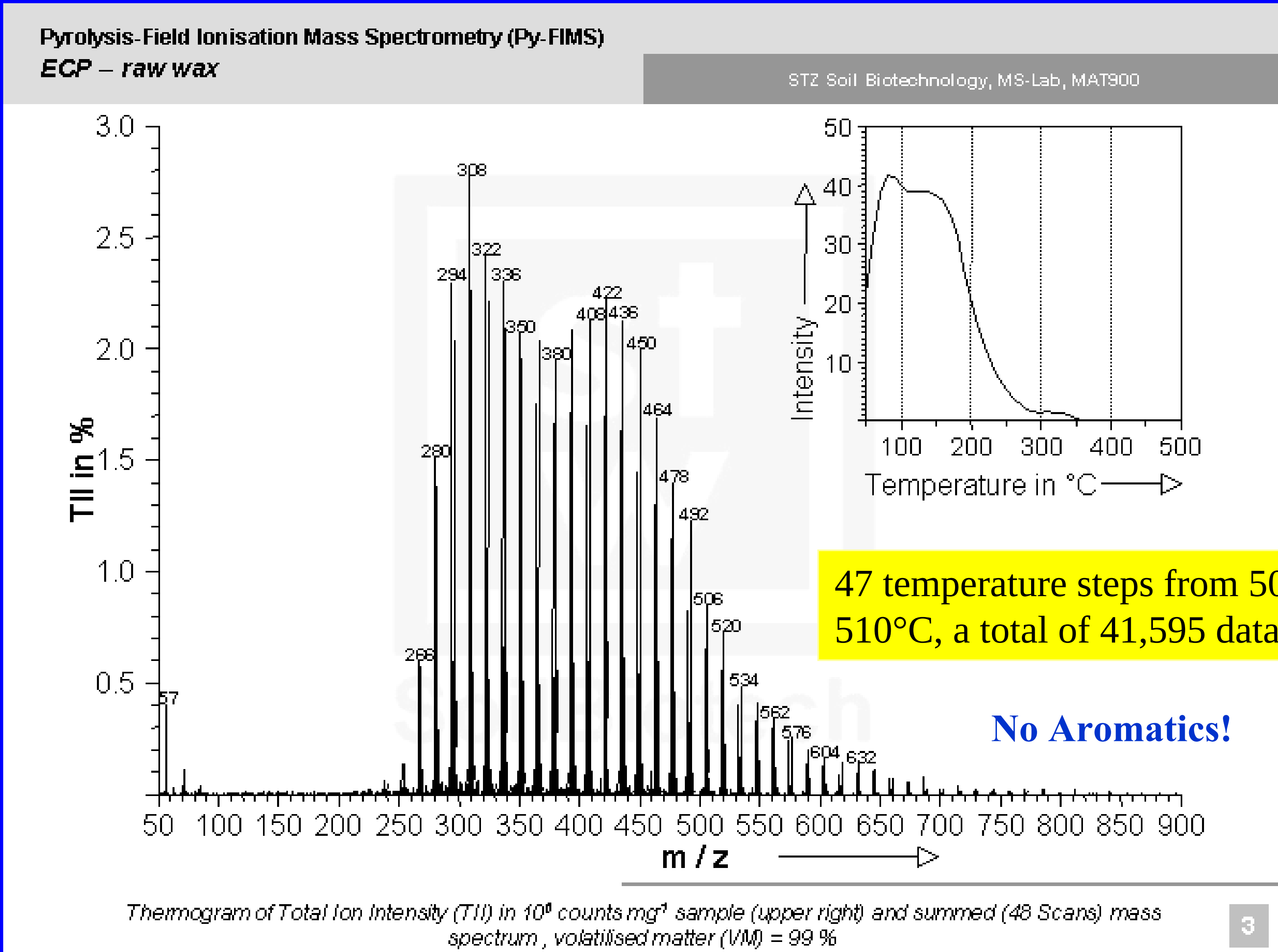


Produced at 330°C

One-pass at 90% CO conversion

Very low amount of gaseous HC

Composition?

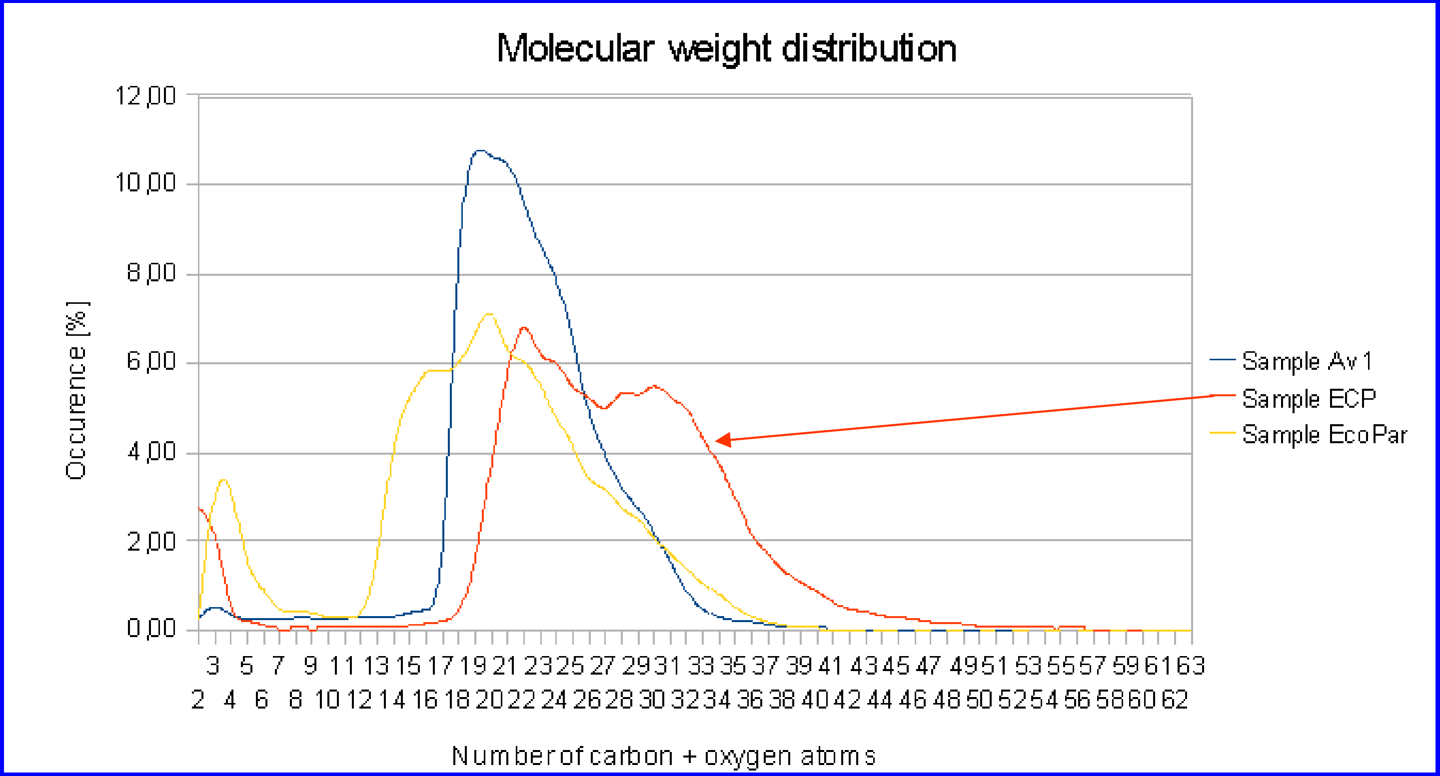


47 temperature steps from 50°C to 510°C, a total of 41,595 data points

No Aromatics!

Occurrence of natural ^{13}C isotope (1.1%) simplifies interpretation of the wax spectrum. As result (%):

Non-cyclic alkanes	**50**
Alkenes	**2**
Mono-cyclo-alkanes	**48**
Di-cyclo-alkanes	**0**
Tri-cyclo-alkanes	**0**



Conclusion

Using the same

- **Syngas**
- **Reactor**
- **Pressure**

ECP is able to tailor the fuel product playing with its various catalysts and process temperatures. The product can be light or heavy according to a local need

We are ready to build a complete demo plant:

GlidArc-assisted clean syngas production from any carbonaceous feed + FT synthesis