



Energy research Centre of the Netherlands

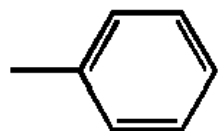
TAR DEW POINT ... and the great extrapolation show...

Bram van der Drift

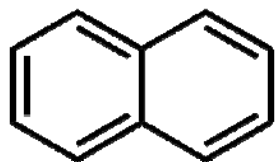


TAR

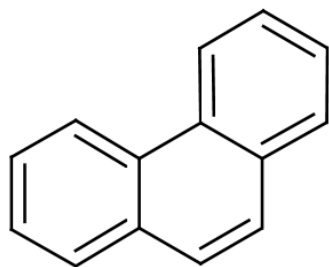
large hydrocarbons



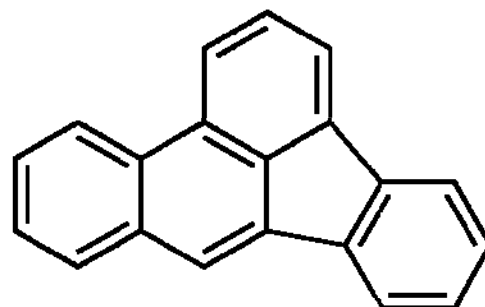
toluene



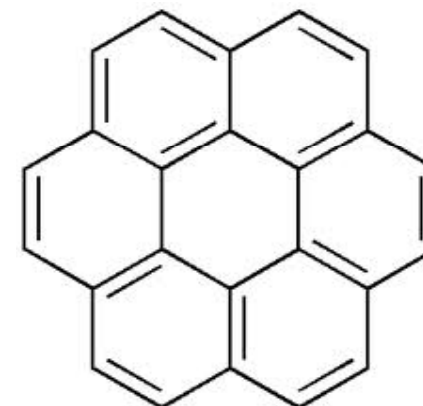
naphthalene



phenanthrene



fluoranthene



coronene

but it does not stop...

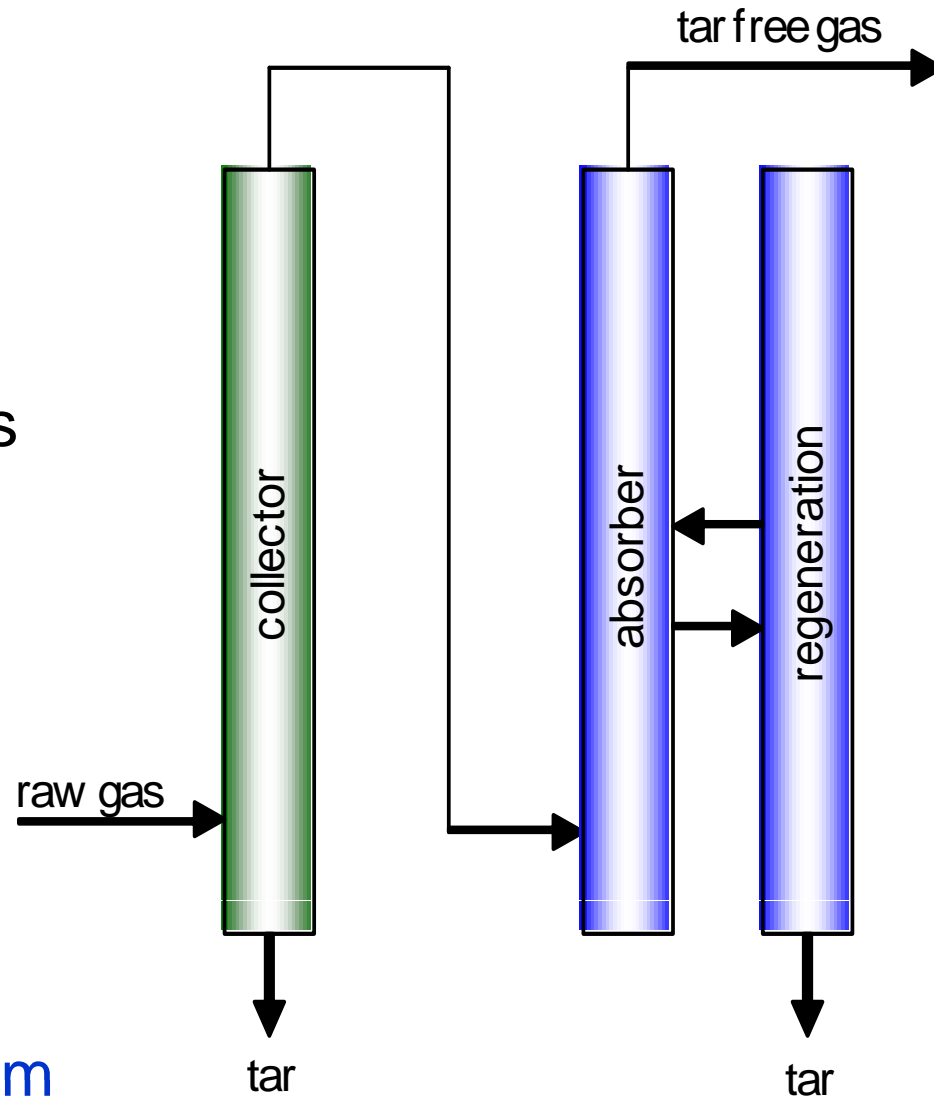
TAR REMOVAL

OLGA technology

- Complete tar removal
- Heavy tars and light tars
- Particles removal
- No methane removal
- Tar recycle

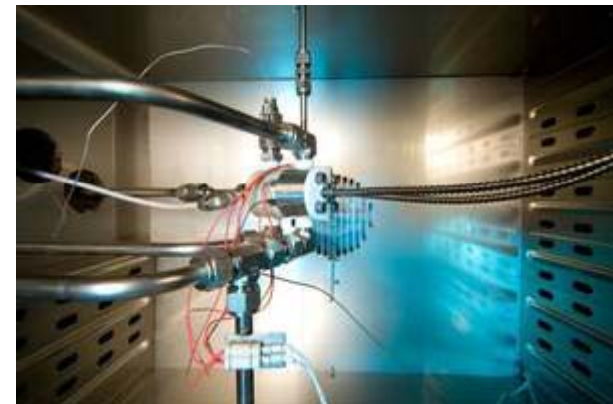


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WHAT DO WE MEASURE?

- SPA: tar content and tar composition
 - Fast and easy
 - But limited to ~ 300 g/mol tar molecules (coronene)
- TDA (Tar Dew point Analyser) developed by ECN
 - Accurate
 - Suitable up to 200°C



TAR DEW POINT CALCULATION

heavy tars dominate

SPA result can be translated to dew point, example with 100 mg/Nm³ coronene (typical max. for fluidized bed)

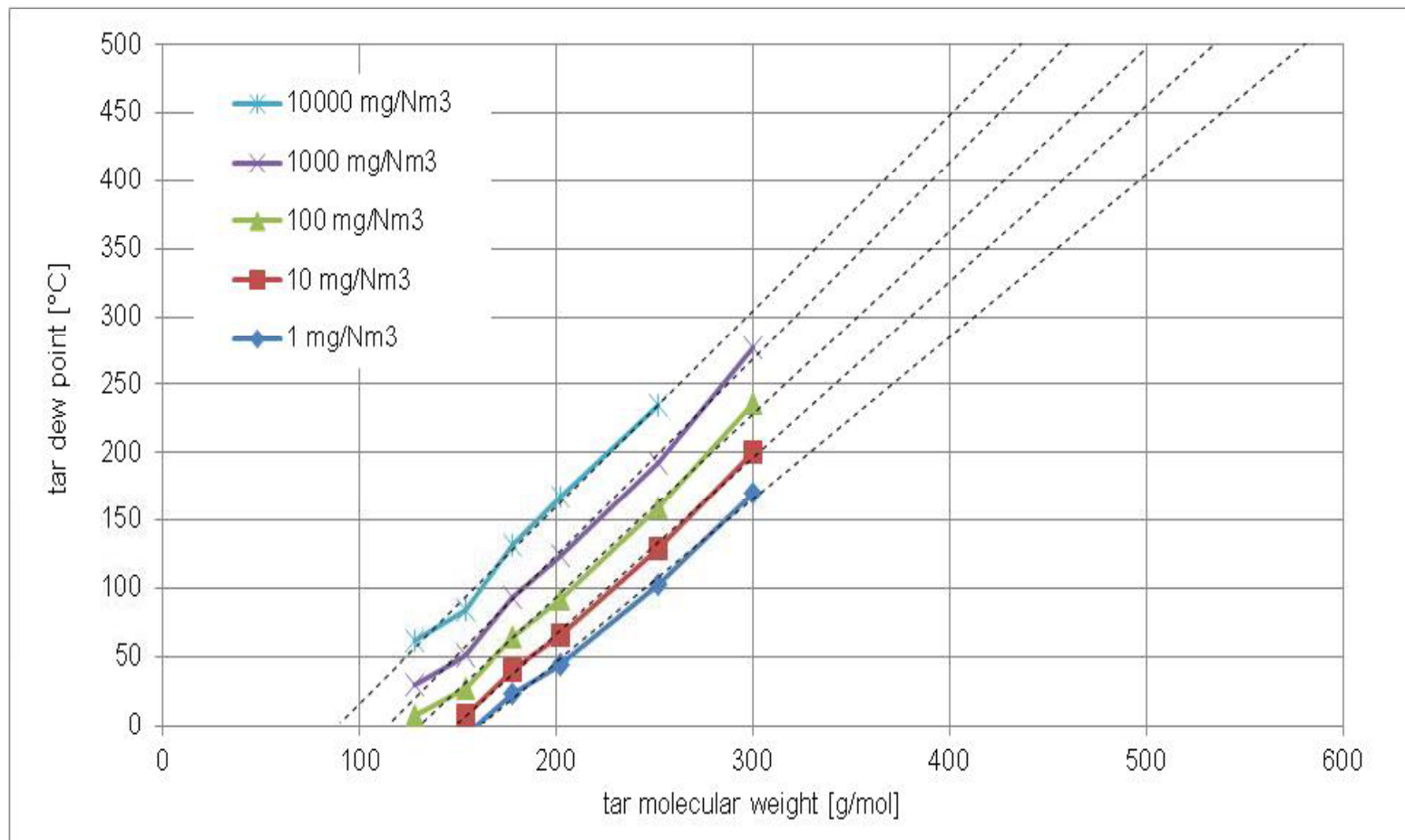
Fluoranthene (202 g/mol)	Benzo(a)pyrene (252 g/mol)	Coronene (300 g/mol)	Dew Point (calculated)
-	-	100 mg/Nm ³	236°C
-	1 000 mg/Nm ³	100 mg/Nm ³	237°C
10 000 mg/Nm ³	1 000 mg/Nm ³	100 mg/Nm ³	239°C

50 g/mol heavier tars dominate tar dew point, even at 1/10th the concentration

TAR REALITY

- Fouling by tar occurs at surfaces with temperature of 300 and even above 400°C
- Clearly, coronene is not the problem
- So, SPA does not quantify the tars that matter
- Guideline gravimetric result does not give information on tar size
- The great extrapolation show...

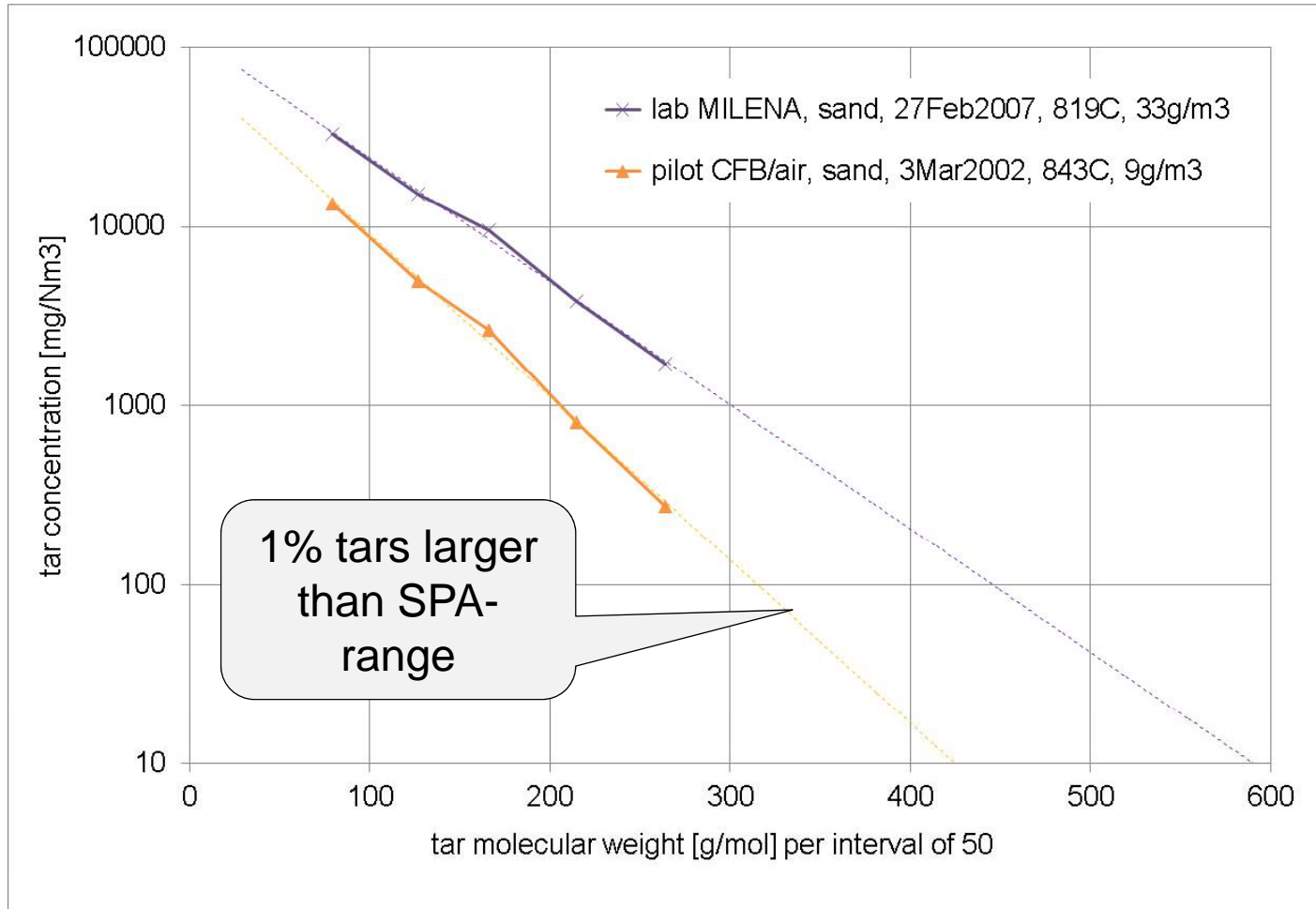
TAR DEW POINT OF LARGER TARS



CONCENTRATION OF LARGER TARS

- SPA results as starting point
- Group the tars in intervals of 50 g/mol:
 - Small enough to have sufficient points over the SPA-range (4 points)
 - Large enough to average peaks to normal
- Adding 5th point: benzene and toluene from micro-GC

CONCENTRATION OF LARGER TARS



CONCENTRATION OF LARGER TARS

	CFB/air - sand	MILENA - sand
<300 g/mol	9 000	33 000
300-350 g/mol	80	650
350-400 g/mol	28	295
400-450 g/mol	10	130
450-500 g/mol	3	59
500-550 g/mol	1	27
550-600 g/mol	0.4	12
% >300	1%	4%

CONCENTRATION OF LARGER TARS

- Rather linear relation!
- Every step of 50 g/mol roughly decreases concentration by factor of 2-3
- This means that every step up in tar molecular mass, increases the tar dew point
- This means that it never ends...

CONCENTRATION OF LARGER TARS

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TD=360°C (pointing to 300-350 g/mol CFB/air - sand)

TD=430°C (pointing to 400-450 g/mol CFB/air - sand)

TD=420°C (pointing to 300-350 g/mol MILENA - sand)

TD=580°C (pointing to 550-600 g/mol MILENA - sand)

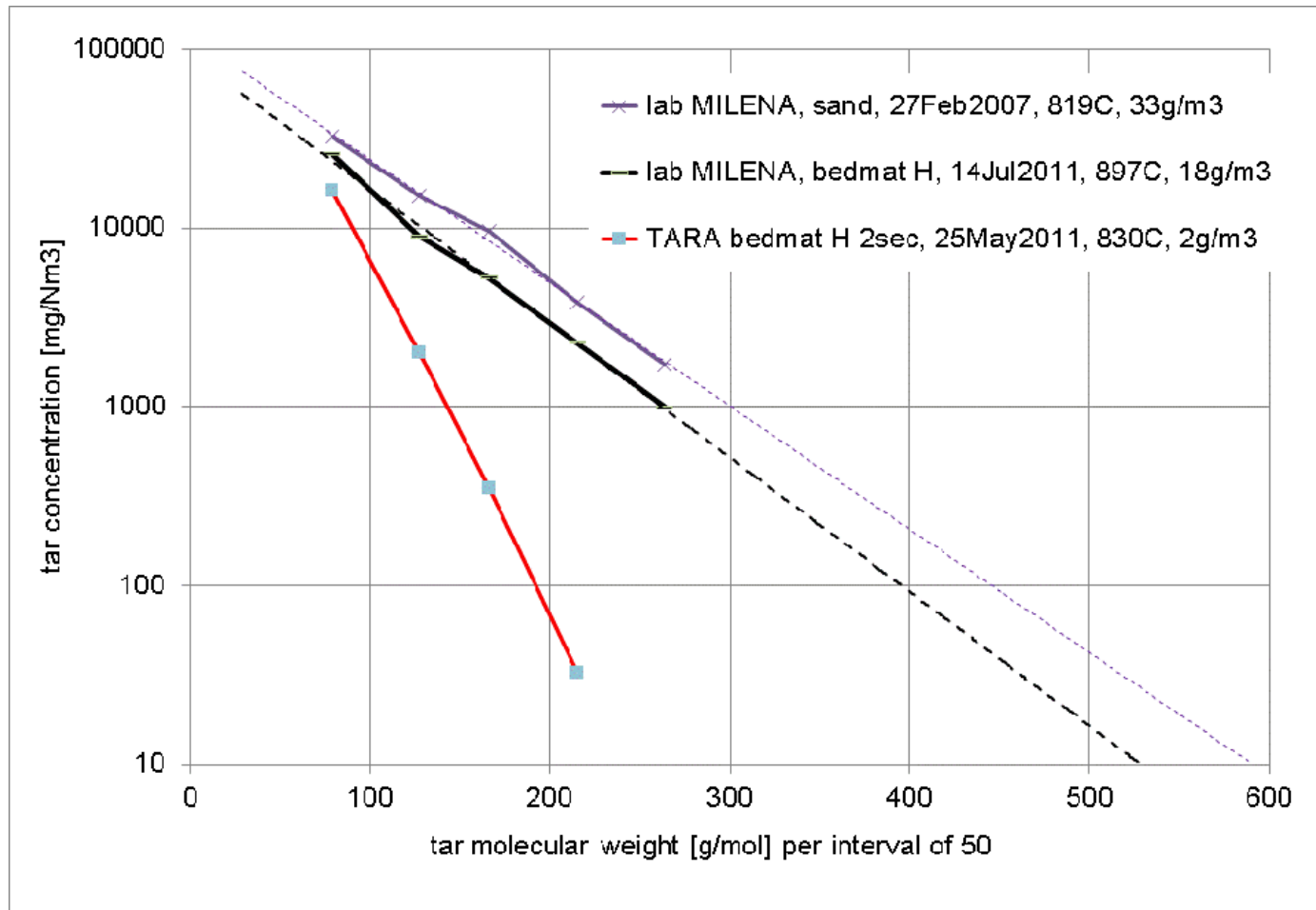
CONCENTRATION OF LARGER TARS

Or the other way around: on a 350°C surface:

- 15 mg/Nm³ tars will condense (CFB/air)
 - 250 mg/Nm³ tars will condense (MILENA)
- blocking will occur 15 times faster

15 mg/Nm³ in 80 MW CFB gasifier means 4000 kg/y

CONCENTRATION OF LARGER TARS



CONCLUSIONS

- OLGA removes all tars, but upstream...
- Tests reveal tar condensation at temperatures as high as 400-500°C
- Measured SPA tars are too small to explain this
- Extrapolation concentration...size seems OK
- Typically only few% tars missing (larger than what SPA can detect), but these are the relevant tars
- Extrapolation leads to conclusion that fixed Tar Dew Point does not exist
- More practical approach needed, e.g. “temperature where less than 10 mg/Nm³ condenses”

MORE INFORMATION

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publications: www.ecn.nl/publications

fuel composition database: www.phyllis.nl

tar dew point calculator: www.thersites.nl

IEA bioenergy/gasification: www.ieatask33.org

Milena indirect gasifier: www.milenatechnology.com

OLGA tar removal: www.olgatechnology.com

SNG: www.bioSNG.com and www.bioCNG.com