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ISL NCK Apparatus Evolution

D5800B Noack Workshop

Sandra Chirk
Product Manager – Physical Properties

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ISL Noack Analyzers

NCK2 Model – 2nd Generation

NCK1 Model – 1st Generation

NCK2 5G Model current

NCK1 Model – 1st Generation

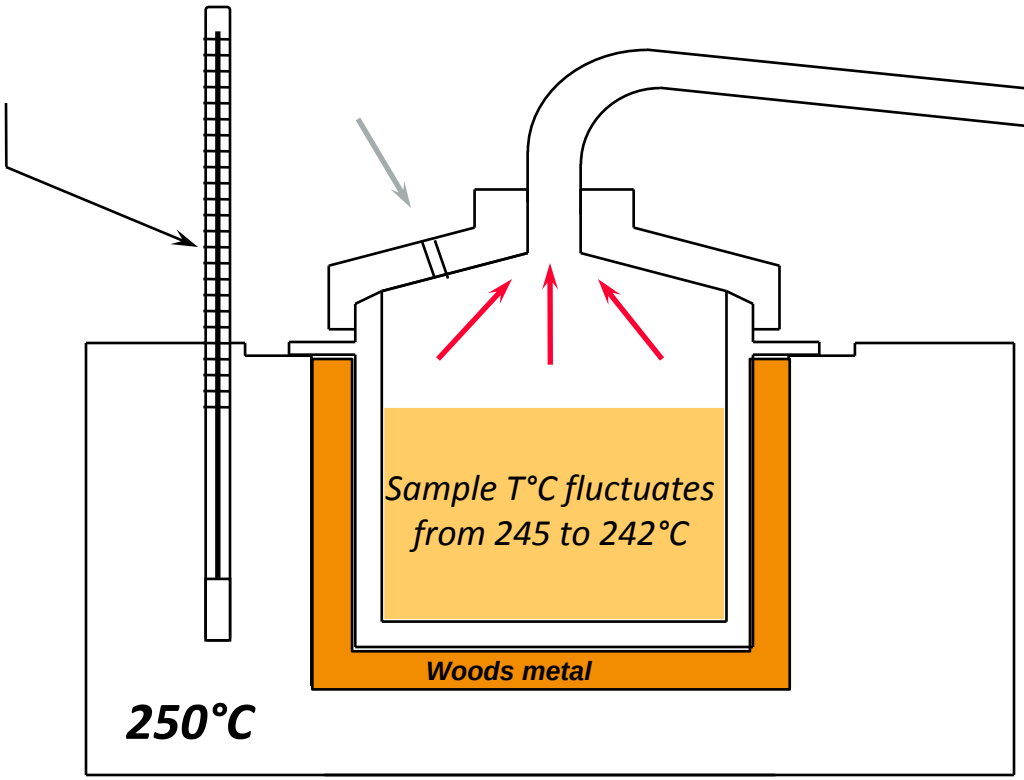
Key Specs

- *Compliance to Procedure A of ASTM D5800; CEC L40 A93 (Proc. A)*
- *Temp. Range : +150 to +300°C*
- *Aluminum block temperature control*
- *Wood's metal heating block*

D5800 – Procedure A

Heating Block T°C control
- resolution: +-0.1°C
- stability: +-0.5°C

Air flow:
from 3 to 5 l/min



- When the air flow varies, the sample temperature changes.
- Heat transfer also varies with specimen viscosity, the sample temperature changes

↘ **The sample temperature must be controlled**

NCK2 Model – 2nd Generation

Key Specs (release in 1998)

- *Compliance to Procedure B of ASTM D5800; CEC L40 A93 (Proc. B)*
- *Temp. Range : +150, 200 or +250°C*
- *Sample temperature control*
- *Non Wood's metal heating block*

What's different with Nck1 Model?? Only the heat transfer changes

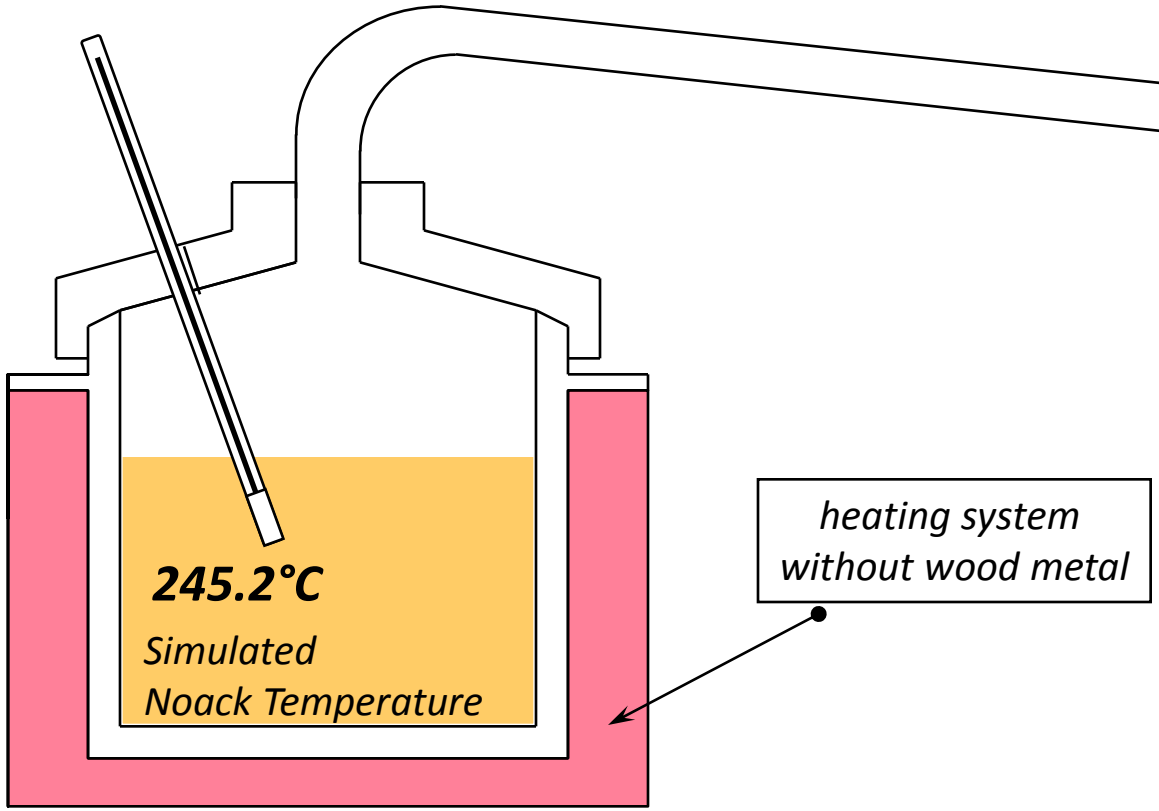
- Same crucible
- Same glassware
- Same vacuum pump
- Same Test Procedure

No use of Wood Alloy and direct sample T°C monitoring

D5800 – Procedure B

Sample T°C control
- *resolution: +-0.1°C*
- *stability: +-0.5°C*

20 mm H_2O Vacuum
(3.8 l/mn in test conditions without sample in the cup)



heating system without wood metal

NCK2 5G Model – Current

Key Specs (release in 2002)

- *Compliance to Procedure B of ASTM D5800; CEC L40 A93 (Proc. B)*
- *Temp. Range : +150, 200 or +250°C*
- *Sample temperature control*
- *Non Wood's metal heating block*

What's different with ISL Nck2 Model??

- Design refresh (benchspace optimization)

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PAC

Improve Noack Methods Precision

Air Flow Influence Study

Outline

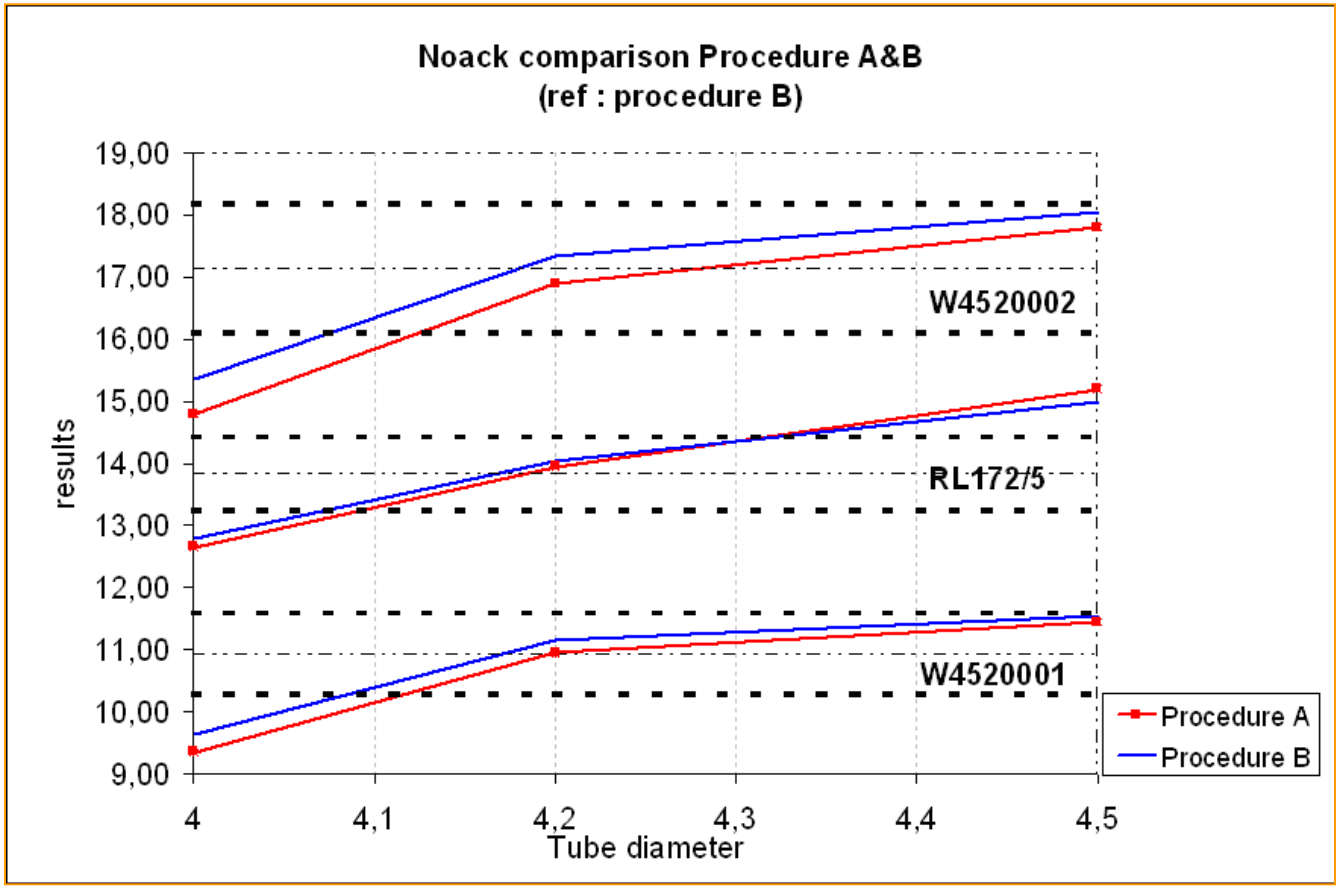
- Background
- Study Results Review
- Conclusions & Actions

Study Background

- **Objectif: Improve Noack method precision**
- **Test Configuration**
  - Single equipment incl. Crucible, temperature probe, pressure controller. 2 x ovens were used, one for procedure A, one for procedure B.
  - Airflow measured with BUCK flow-meter (using bubble soap)
- **Experiment**
  - Three reference oils with known performance
    - Base stock oil RL172/5 : 13.95% (Proc. A); 14.36% (Proc. B)
    - Formulated oil W4520001 : 10.5% (Proc. A); 10.85% (Proc. B)
    - Formulated oil W4520002 : 17.14% (Proc. B)
  - Test performed, in replicate, using 3 x different tube diameters (∅4mm, ∅4.2mm, ∅4.5mm) and according to standard conditions
    - Procedure A : oven at 250°C, time duration 60min
    - Procedure B : Sample at 245.2°C, time duration 60 min

Improving Method Accuracy

Influence of extracting tube diameter



Bias between Procedure A an B

Mean bias between Procedure B and Procedure A is 0.25%

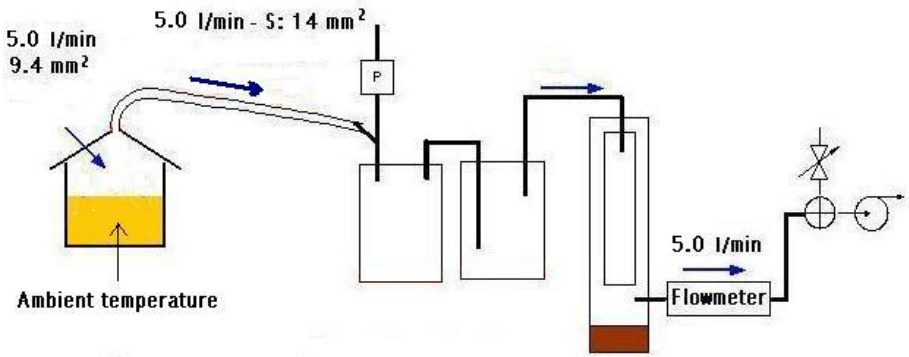
Bias increases when evaporation loss increases

Improving Method Accuracy

Influence of Air Flow

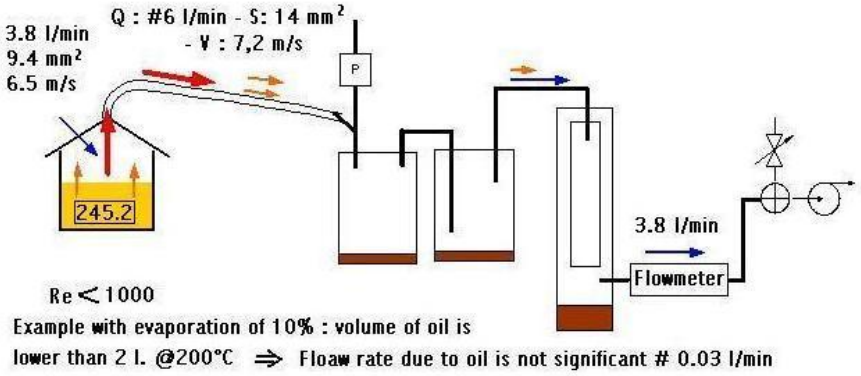
GENERAL DIAGRAM OF NOACK METHOD B

AT THE BEGINNING OF THE TEST PROCEDURE



GENERAL DIAGRAM OF NOACK METHOD B

AT THE TEMPERATURE EQUILIBRIUM



The flow rate does not depend on sample; evaporation loss nor procedure

Flow rate changes during the test:

At test start: flow rate is limited by injector diameter (>5l/min)

At the T°C equilibrium: flow rate decreases and is limited by tube diameter

The flow rate depends on tube diameter.

	Tube diameter	Procedure A	Procedure A&B *(l/min)*	
		Temperature	*Airflow (0 min)*	*Airflow (30 min)*
RL172/5	4.0 mm	*245.2*	*4.4*	*3.3*
	4.2 mm	*244.8*	*5.2*	*3.8*
	4.5 mm	*244.6*	*5.3*	*4.3*
W4520001	4.0 mm	*244.4*	*4.35*	*3.4*
	4.2 mm	*244.1*	*5.1*	*3.8*
	4.5 mm	*244.0*	*5.3*	*4.3*
W4520002	4.0 mm	*244.4*	*4.3*	*3.4*
	4.2 mm	*244.2*	*5.0*	*3.8*
	4.5 mm	*244.1*	*5.15*	*4.3*

Improving Method Accuracy

Air Flow Adjustment Experiment

- To confirm airflow influence on the result, 2 extreme values of a 4.35 mm nominal tube diameter (∅4.0 and ∅4.5) were used together with RL172/5*.
- Pressure value was modified to maintain 3.8 l/min airflow during the test (evaporation phase).

Test conditions	20mm H_2O	3.8l/min
Tube ∅4.0	12.8% (airflow 3.3 l/min)	13.8% (25.2 mmH_2O)
Tube ∅4.5	15.0% (airflow 4.3 l/min)	14.2% (18.8 mmH_2O)

*Base stock oil RL172/5 expected value: 14,36% (proc. B), 13,95% (proc. A)

Conclusion: Bias due to airflow shift is about 2% / (l/min).
The nominal airflow value should be set at 3.8l/min.

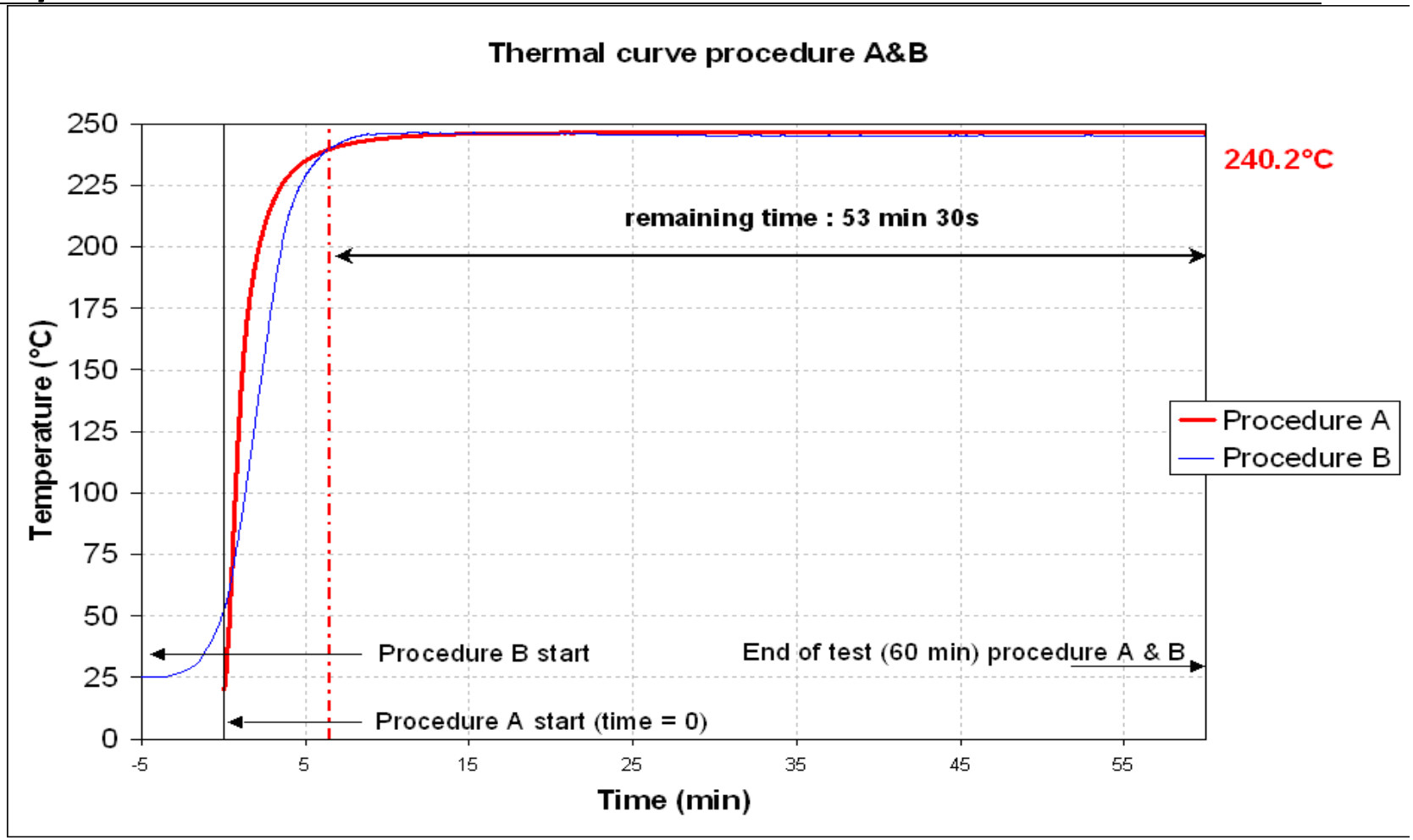
Reducing bias between Proc. A & B

sample temperature definition

- With procedure A, the crucible is immersed into wood metal block maintained @ 250°C.
- The energy exchange is so efficient that the sample heating rate (from ambient up to 200°C) is 70°C/min.
- The stabilisation of the sample temperature is reached within 15mn
- With procedure B it was not possible to get the “A” energy exchange without over heating effect of the crucible wall.

Sample T°C Profile

Comparison between Procedure A & Procedure B



Conclusion: Alignment of the 2 sample T°C profiles by synchronizing the time near equilibrium temperature

Summary

- Airflow has a significant impact on Noack Evaporation Loss for both procedure A and B.
- To improve precision of NOACK method, we need to make sure that air flow is correctly set in the field (previous studies had recommended 3.8l/min)
  - PAC-ISL already control all the extracting tubes meets diameter conditions (tube ∅4.2mm, for 3.8l/min), therefore increase pressure loss control and sorting only diameter but by measuring flow rate that must help to increase precision.

- Should we work on checking procedure to be indicated in the test method?? Round Robin can be organized in order to:
  - The best (but expensive) solution consists on measuring the airflow during the test with the airflow meter described in the experiment (BUCK with "bubble soap")
  - An alternative method can be used with no additional material, simply by using pressure level indicator (already existing) to measure level difference in 2 conditions. Initial condition is use complete crucible, the other condition consist in reducing the "pressure loss" entry to maximize the "pressure loss" of the tube.