Capture efficiency and completeness in accumulative sampling with solvents: measurable descriptors?

M. Kleinhappl
J. Zeisler

thermal gasification

General

Accumulative sampling procedures of volatile organics underlie combined mechanisms of **mass transfer, phase transition** and **equilibrium**.

Already extraction of the sampling gas is often interfered from the solid precipitation of particulate and aerosol matter from the sampling gas. A certain share of this collection is desired, but side effects like adsorption, aerosol interception not.

In accumulation itself a **complete capture** should be reached, but is interfered from water content. The performance of **sampling completeness ('capture' η)** and overall **mass transfer power (activity product *'[k*A]'*)** can be used as descriptors for the suitability of a system (apparatus-setting).

Finally the type of sample produced should be best compatible with the planned analysis, by means of identification and quantification.

Descriptors for liquid interceptors

The following solvents properties of Table 1 are representative for sampling procedure and analysis.

Table 1: Solvent specific parameter

parameter	effect	good	bad
boiling point or saturation pressure	Further sharpeness separation, solvent loss	High: small losses low: analysis, grav. determination	low: solvent losses high: analysis, grav. determination
solubility for polar	Pyrolysis tar water	Complete solution	No separation of water incomplete solution
solubility for non polar	High temp tar, sep. of water	Separation of water	No separation of water
interception of water	Common dissolution, no ice-formation	Low temp. sampling, grav. determination	Ice formation 2-phase in storage discrimination
chromatographic position	GC early HPLC Uv-activity/ fluorescence	GC: light solvents HPLC: inactive solvents	GC: heavy solvents HPLC: interaction detection / column
Safety conditions	Hazards: Fire, persons, disposal	Semi-volatile & indifferent	Volatile & hazard

Saturation pressure of solvents

The most descriptor of present substances is the saturation pressure: Figure 1 is divided into left: alcohols, right a-polar solvents.

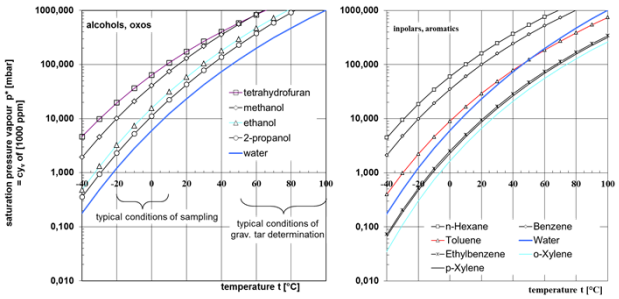

Figure 1: Saturation pressure of typical solvents for liquid sampling

Saturation losses during the operation of 1 m³ gas volume are shown in Figure 2, based on complete saturation at final temp.

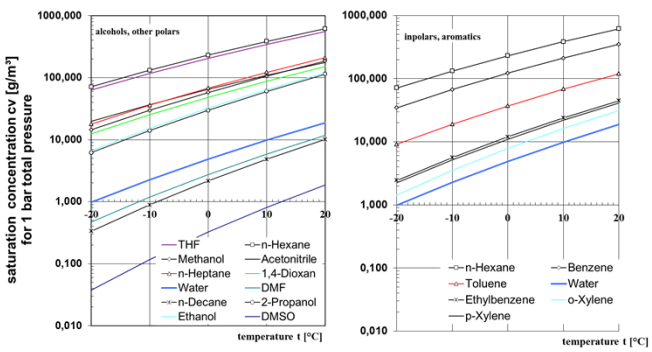

Figure 2: Calculated solvent losses for saturation, total pressure 1 bar.

Test gas generator for capture-tests

A proven setting of a is shown in the Figure 3.

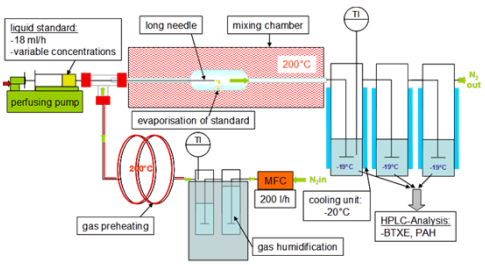

Figure 3: Test gas generator concept used, right test object

With the test gas generator concentrations between 1 and 1000mg/m³ can be realised in the carrier gas flow. Humidity can regulated up to dew points of 60°C.

Figure 3 indicates as test object ***double jacked impingers*** of **columns type**, but all other sampling equipment can be validated with this concept (see presentations *J. Zeisler 2012*).

Holdback/loss in heated particulate filter

As first object of validation the particulate filter in a sampling line is validated with selected BTXE and PAH and results shown in Figure 4.

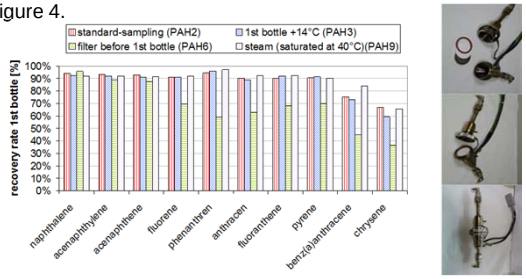

Figure 4: Transmittance of a heated filter (particulate filter @ 180°C, 200l/h gas flow, without carbonous dust or other)

Capture in accumulation solvents

In Figure 5 a dynamic test for the capture of light aromatics (1 & 2 rings) is documented: (loading and stripping)

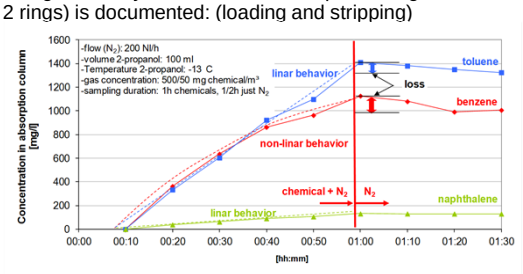

Figure 5: Dynamic test in a 1-stage impinger setting

Descriptors for mass transfer power

In Figure 6 the dynamic test is evaluated on the liquid concentration and [k*A] is expressed via balance computation.

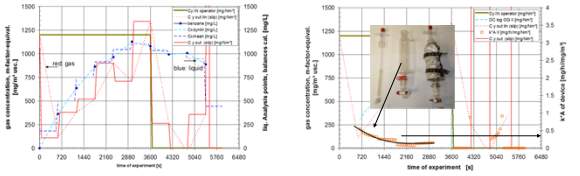

Figure 6: Dynamic evaluation of capture, slip stream and masstransfer-rate (volumetric) for benzene.

The comparative descriptor of capture potential: *[k.A]* is defined from the bubble-swarm & all other mechanisms before (aerosol interception, …). This method should be applied for future evaluation of diff. accumulation apparatus (Impinger II-Gen).

Present poster was prepared for the *3rd. international Gas Analysis Workshop*, about detail 'tar & sulphur' sampling and analysis. *21st. European Conference about Biomass in Kopenhagen June 2013.*

In detail the poster is presenting specific knowledge, which is relevant within the working area of sampling and analysis.

Specific experience in this item is useful for comprehension.

BIOENERGY 2020+ GmbH

Inffeldgasse 21 b
A 8010 Graz
T +43 (0)316 873-9201
F +43 (0) 316 873-9202
centre@bioenergy2020.eu

www.bioenergy2020.eu

FFG bmvit bmwfj Wachsen mit Europa WIBAG Das Land Steiermark SFG COMET
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