

# Operating Manual

## Residual oil sampling

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# RESIDUAL OIL SAMPLING

## Table of contents

<b>1</b>	<b>Manufacturer's information</b>	<b>3</b>
<b>2</b>	<b>Scope of supply</b>	<b>4</b>
<b>3</b>	<b>General dangers and warnings</b>	<b>5</b>
3.1	Safety instructions	5
3.2	Safety instructions for compressed air systems	5
3.3	Safety instructions for Absorber tubes	5
3.4	Intended use	6
<b>4</b>	<b>Selection of procedure</b>	<b>7</b>
4.1	Hydrocarbons and Aerosol	7
4.2	Sampling in plant without Aerosol	7
4.3	Sampling in plant with Aerosol	7
<b>5</b>	<b>Background information</b>	<b>9</b>
5.1	Standards	9
5.2	Hydrocarbons in compressed air	9
5.3	Analysis of compressor oil	9
5.4	Functioning of the test tubes	10
5.4.1	Reference to standards	11
5.4.2	Ready-to-use sampling tubes	11
5.4.3	Behaviour at Breakthrough	12
5.4.4	Application of sampling tubes	13
5.5	Flow rate in sampling tubes	13
5.6	Evaluation procedure	14
5.6.1	IR Spectroscopy (FTIR)	14
5.6.2	Gaschromatographic evaluation (GC-FID)	14
5.6.3	Mass spectroscopy	14
5.7	Residual oil Classes	14
5.8	Characteristics of the GC-FID measuring procedure	16
5.9	Standard conditions	16
<b>6</b>	<b>General information on application</b>	<b>17</b>
6.1	Care and cleanliness	17
6.2	Responsibility	17
6.3	Inspection of the plant	17
6.4	Location of sampling	17
6.5	Basic conditions	17
6.6	Flow rate	18
6.7	Time span for sampling	18
6.8	Documentation of application and the results	19
6.9	Results	19
<b>7</b>	<b>Sampling</b>	<b>20</b>
7.1	Preparation work	20
7.2	Withdrawal location	20
7.3	Withdrawal point	20
7.4	Connection to a compressed air outlet	20
7.5	Withdrawal lance	21
<b>8</b>	<b>Operational sequence of sampling</b>	<b>21</b>
8.1	Start of sampling	21
8.2	Completion of sampling	23
8.3	Analysis report	25
<b>9</b>	<b>Detected substances</b>	<b>26</b>
9.1	Aliphatics	26
9.2	Alcohols	26
9.3	Aromatics	26
9.4	Esters	26
9.5	Halogen hydrocarbons	26
9.6	Ketones	26
9.7	Nitrile Terpenes	26
9.8	Other VOC	26
<b>10</b>	<b>Order conditions</b>	<b>28</b>

# RESIDUAL OIL SAMPLING

## 1 Manufacturer's information

Manufacturer's information	
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**Many thanks that you have decided for our laboratory!**

The service of residual oil measurement provides an extended capability to compressed air dealer, and hence, gives a renewed chance of customer retention.

Our laboratory guarantees precise, repeatable results through methods conforming to standards and use of most modern analysis equipment and documentation as per ISO 9001 standard.

This operating manual is to help you with the sampling. The information is important, in order to obtain optimal results and eliminate safety risks. Hence, please always keep this manual!

**We wish you great success and look forward to your co-operation!**

# RESIDUAL OIL SAMPLING

## 2 Scope of supply

The Residual oil sampling set is supplied in ready-to-use condition. It is a rented device and must be returned to us in full after sampling.

Alternatively the probe set is also available for sale. In this case, the complete probe tubes mounted in a holder are sent in an exchangeable system. The rest of the components remain with the customer.

The following components are covered in the scope of supply of rental set:

- (1) Tube holder with Splinter guard
- (2) Ready-to-use and checked sampling tubes (placed in the tube holder)
- (3) 2 mm outer- $\varnothing$  PTFE-hose (white) for compressed air system with 6/4 mm adapter
- (4) Withdrawal lance with 1/8" connection
- (5) Adapter set, ball valve, plug 7.2mm for compressed air coupling, silencer
- (6) Floating body flow meter with needle valve and connection hose (blue)
- (7) Ball valve with clamping ring connection (for sample withdrawal) and sight glass
- (8) Combined temperature, humidity and atmospheric pressure instrument
- (9) Latex hand gloves, safety goggles, PE-transparent bag
- (10) Return envelope with address label
- (11) Carry case, with operating manual and sampling report format

### Picture of individual components



Please read the operating manual of the product before putting into operation. Apart from the operating instructions, there is also important information in various chapters about installation, commissioning and trouble shooting.

# RESIDUAL OIL SAMPLING

## 3 General dangers and warnings



Please carefully read the following warnings before putting into operation! The symbols used in the operating manual are to make you alert on safety risks. But any of the symbols used can not replace the respective safety instructions. Therefore, text should always be read fully!



This symbol indicates likely danger to persons, material or environment. The information provided in the associated text should be duly followed to avoid any kind of risk.

This symbol signifies important application notes and tips, which are necessary for successful working and should be absolutely followed to ensure good results.

### 3.1 Safety instructions



It should be noted that often there is an increased hazard potential for the users and outsiders in the vicinity of measuring points. Therefore, particularly a sensible behaviour and increased caution is necessary. The applicable standards and rules of technology must be taken care of.

The work should be entrusted to only those persons who are adequately trained with the job requirements. The work must be carried out carefully and attentively. The applicable safety and accident prevention rules should be absolutely considered.

For safety reasons and to achieve optimal working results, arbitrary changing of functional parts and/or modification of the product is not allowed.

### 3.2 Safety instructions for compressed air systems



The energy stored in compressed gas can lead to unforeseen incidents causing injuries or damage to objects. The risk increases as per the operating pressure of the plant. Hence, all activities should be performed by only trained personnel. In all activities at the compressed air system, a corresponding level of care is necessary to avoid any damage! It is recommended to wear a goggle. The loud disturbing noises caused by uncontrolled opening of lines under pressure can cause damage to hearing or frighten other persons in the vicinity. At high flow rates, the foreign bodies swept along can act like projectiles and cause injuries to skin or eyes.

### 3.3 Safety instructions for the absorber tubes



Caution! The test tubes are made of glass and stand under pressure during use. In order to prevent flying around of splinters with possible bursting of the test tubes, these should be only used in special holder with splinter protection. The test tubes are checked only for a plant pressure of up to 10 bar and should not be used for higher pressures.

Caution! The broken off glass ends of the test tubes are razor-sharp and hold a substantial risk of injury. If the tubes have been provided with holder, then they should be left in the holder itself and should be closed after the sampling and sent back with the holder. The handling must be done very carefully, in order to avoid any injury risk.

# RESIDUAL OIL SAMPLING

## 3.4 Intended Use



The Residual Oil sampling set is meant for measurement of hydrocarbons in compressed air systems.

Analysis equipment/measuring instrument are sensitive and must be handled carefully: Avoid impact, shocks and vibration. In case of external intervention, the guarantee will become void.

A measurement under critical ambient conditions (explosion guns environment, combustible gases, steams or solvent, etc.) is not allowed.



Any use other than described above can lead to damage of the device. Moreover, it can also involve danger like, for example, explosion etc. The product should not be opened, modified or rebuilt!

Please take care of the following points during application:

4 Take care of the application temperature and pressure range. Maximum allowed pressure is 10 bar. The maximum temperature at the time of sampling should not exceed 30°C.

4 Do not expose the device for a long time to high temperatures, also not during transportation or in KFZ. Keep the device in carry case after use in order to avoid any damage.

4 Consider the technical background of the measuring procedure, specially the standard series ISO 8573, for safe handling and to achieve accurate results.

4 Immediately send the drawn samples for analysis. Prolonged storage at high temperatures leads to distortion in measurement results.

In principle, it can said: If you have any questions, you should contact us before you risk errors and damages due to wrong handling!

Your contact person at our end is :

Mr. Ralf Kotzock

Tel. 089 / 81888 234

email [Info@pro-air.eu](mailto:Info@pro-air.eu)

# RESIDUAL OIL SAMPLING

## 4 Selection of procedure

### 4.1 Hydrocarbons and Aerosol

Nearly all residual oil measurements are carried out in plants, in which there is a very high level of quality requirements. Therefore, normally due care is taken through filters and absorbers/catalyst, and only few hydrocarbons are noticed in the plant. The hydrocarbons are all in the gaseous phase. Aerosol may not be present in such plants.

Therefore, aerosol can occur only due to disorders, generally when many filters in sequence would have failed. If aerosol appears even in smallest oil drops, the compressed air gets over-saturated and considerable amount of oil is noticed in the compressed air network. Moreover, the chain length of registered hydrocarbons of short chains (volatile) hydrocarbons shifts to the considerably long chain and non-volatile components. The plant gets contaminated.

### 4.2 Sampling in plants without Aerosol

The procedure with test tubes (without upstream glass fibre filter) is only suitable for measurements up to compressed air residual oil Class 1 and 2 ( $< 0.1 \text{ mg/m}^3$ ) and also conditionally suitable (if no aerosol is present) for Class 3. Aerosol in compressed air would not allow Iso-kinetic sampling and the absence of aerosol filter would lead to high quantitative deviations of the measured values.

However, aerosol is to be recognized immediately in the Chromatogram, since the portion of long chained components increases drastically. This also enriches more oil in the breakthrough zone, since the aerosol partly passes through the main zone.

Therefore, such a critical plant condition is immediately recognized in the Chromatogram, in which the quality report is given.

If aerosol presence can be assumed unlikely, a sampling in the region, directly after the compressed air treatment stage, is enough. In case of special high requirements of benchmarking, several measurements at different points in the plant should be carried out.

### 4.3 Sampling in plants with Aerosol

If the hydrocarbons with quantitative aerosol component are to be determined, the expenses are much larger:

1. The withdrawal of compressed air must be iso-kinetic in a rising line. For this, an elbow with inlet and outlet plug is required which must be installed in the plant. The sampling must be done isokinetically, i.e. the flow velocity in the sampling lance must be adapted to the flow velocity in the elbow of the plant. The exact reasons and details are described in the standard ISO 8573-2.

2. For the determination of aerosol, a glass fibre filter is required, which is connected before the active charcoal filter in the gas stream.

3. The evaluation in laboratory is carried out in two steps. The aerosol content in the glass fibre filter and the gaseous hydrocarbons collected in the column are analyzed separately.

Corresponding components are available with us on rent. With enquiries, we need the operating data of the plant for dimensioning of the tube cross section and elbow piece.

### 4.4 Isokinetic sampling

# RESIDUAL OIL SAMPLING

The sampling is done in an elbow piece in which a withdrawal lance centrally projects in the compressed air line.

In order to ensure that the sample taken with the branched out stream by lance has aerosol content in the same proportion as in the compressed air line, the flow velocity of the branched out stream in the lance should be exactly same in intensity as in the compressed air line.

Moreover, it is also necessary that the flow in the compressed air line is homogenised over a straight inlet section before entry into the withdrawal lance.

In case of turbulent pipe flow, to achieve a desired stabilisation of the flow profile, theoretically an inlet passage with 50 times the pipe inner diameter is required. In case of large pipe diameters, this is often not feasible.

In practice, the following values are well proven:

Length of the inlet segment:  $15 \times D$

Length of the lance, which projects in the inlet passage:  $3 \times D$

Radius of the pipe bend:  $5 \times D$

Outlet segment:  $10 \times D$

For an optimal result, it is necessary that the lance projects in the vertically mounted rising line. The end face is in the stream.

Furthermore, the compressed air plant should have already run for two weeks in normal operation so that all the operating parameters must have stabilised.

# RESIDUAL OIL SAMPLING

## 5 Background information

### 5.1 Standards

Following standards are relevant in the field of Hydrocarbon determination:

ISO 8573-1:2001	Compressed Air- Contaminants and purity classes
ISO 8573-2:2001	Test methods for aerosol oil content
ISO 8573-5:2001	Determination of oil vapour and organic solvent content

The original text of above standards can be obtained from Beuth publishers in Berlin.

### 5.2 Hydrocarbons in compressed air

The oil quantities which can be present in compressed air are very different. Properly treated compressed air contains very small quantities of hydrocarbons, which are difficult to measure. However, directly after the compressor, very large quantities of residual oil can be present in compressed air.

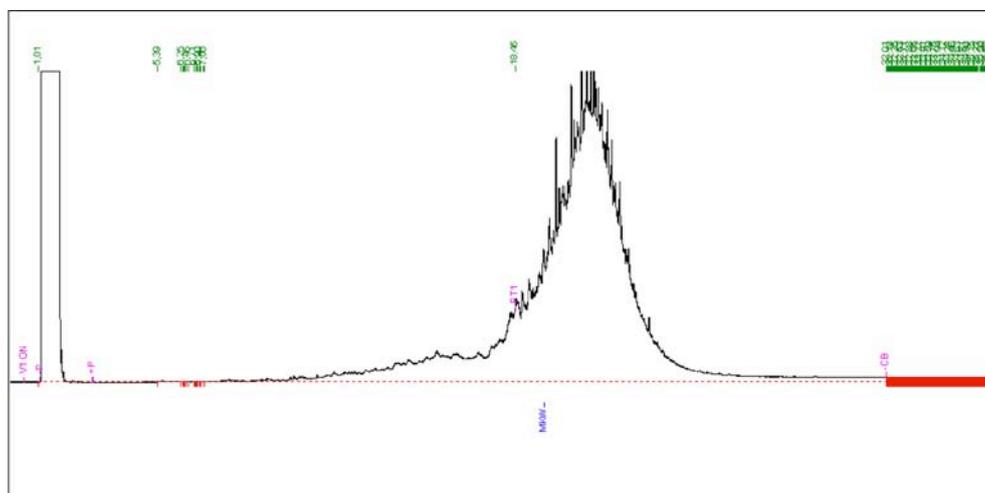
Typical measured values in plants are:

Plants with catalyst	< 0.001 mg/m <sup>3</sup>
Plants with active charcoal adsorber	approx. 0.005 mg/m <sup>3</sup>
Plants with SMA-Filter	approx. 0.1 mg/m <sup>3</sup>
Plants without filter after the cold dryer	approx. 0.5 to 1 mg/m <sup>3</sup>
Directly after the compressor, in air reservoir	upto 20 mg (Aerosol)

The hydrocarbon content very strongly depends on the temperature. At higher temperatures, more hydrocarbons are present in the compressed air.

### 5.3 Analysis of compressor oil

The following Chromatogram shows the typical composition of lubricating oil. From the Chromatogram, it can be understood that lubricating oil used in compressors is a very long chain compound. The main components lie in the chain length of over C30.



# RESIDUAL OIL SAMPLING

## 5.4 Functioning of test tubes

The hydrocarbon content in compressed air is relatively small. Therefore, it is necessary that the oil present in compressed air is to be enriched first, so that it can be determined with an analyser. This enriching is done by allowing the flow of a larger volume of air through the sampling tube with activated charcoal.

The test tubes contain the so-called "Sorbiens " through which a certain measured volume of test gas is flown through. During the flow, the Sorbiens absorb the hydrocarbons contained in the gas flow and store them in the pores. Hence, over the flow rate and the time period of test gas flow, the volume of the carrier gas and also the material quantity retained in the Sorbiens can be determined. Hence, the Sorbiens enrich themselves by the hydrocarbons.

After sufficient amount is present, the sampling is concluded. The tube is opened in the laboratory and extracted with a solvent. Now the hydrocarbons are in the solvent, which are quantitatively analysed by means of gas chromatography.

Compressed air volume +  
Hydrocarbon

Hydrocarbon in  
the Sorbiens

Hydrocarbon  
in solvent,

Gaschromatographic Analysis  
Analyse (



e.g. 0.08 mg/m<sup>3</sup>  
2l/min over 16 h  
= 1920 l = 1.92 m<sup>3</sup>  
air  
=> 0.1536 mg = 153.6 µg

In example 153.6 µg

e.g. 2 ml solvent  
In example: 153.6µg/2 ml  
76.8 µg/ml

Result in example 76.8 µg/ml  
Now calculate backwards:  
=> 153.6µg in tubes  
=> 0.08 mg/m<sup>3</sup> in the compressed

# RESIDUAL OIL SAMPLING

## 5.4.1 Reference to standards

In the standard 8573-1, the sampling procedure and quantitative analysis of vapour forming hydrocarbons present in compressed air with the help of gas chromatograph and mass spectrometer detector has been described. As per the standard, the hydrocarbons with a chain-length of 6 (Hexane) to C40 (Tetradecane) has been defined.



In the standard, a test tube filled with active charcoal has been described, which is filled with approx. 3 g of active charcoal in the main zone.

However, the handling of such test tubes should be limited to experts. Therefore, it is our responsibility to simplify the sampling procedure so

much that also only technically experienced persons without chemical technology training can also carry out the sampling with very low chances of error.

Note: On request, we can also supply you stainless steel test tubes with the geometry as specified in the standard!

## 5.4.2 Ready-to-use sampling tubes

For many years, test tubes filled with active charcoal are being used for environment monitoring. These tubes are of glass and sealed at the ends. These can be stored up to 5 years, however, it is suggested to consider the printed expiry date.

The tubes used by us have two layers separated by glass wool as separator:

- The main zone, in which the enriching is normally taking place
- A control zone, also known as backup zone which registers the breakthrough.



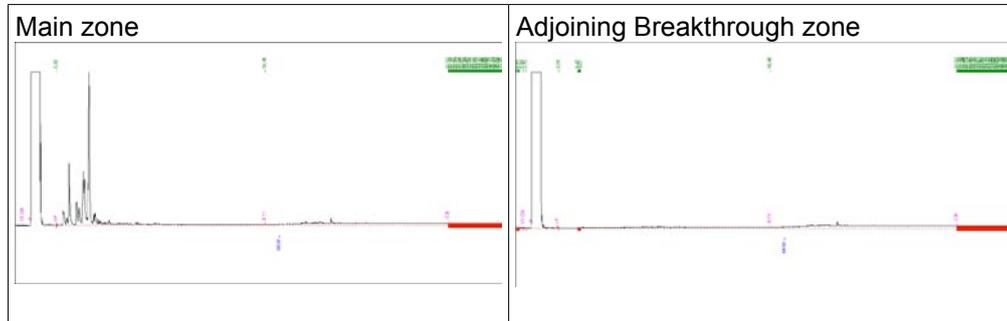
In main zone, the hydrocarbons are collected. The control zone enables to determine whether a "Break-through" has taken place, that means whether significant quantity of hydrocarbons has not been absorbed in the main zone. After that, both zones are extracted separately with a solvent and quantitatively analyzed. If the amount of material in the control zone is less than 25%, then the sampling is in order. The sum of both analyzed values is the result of measurement.

If more than 25% of the hydrocarbons are found in the control zone, then a "Break-through" has taken place. This can be, for example, a case in which the sampling has been done at a higher flow rate or if aerosols were present in the compressed air. In such a case, the reason for break-through must be eliminated and the sampling to be repeated.

# RESIDUAL OIL SAMPLING

## 5.4.3 Behaviour at Break through

The following chart shows a typical Chromatogram for correct successful sampling:

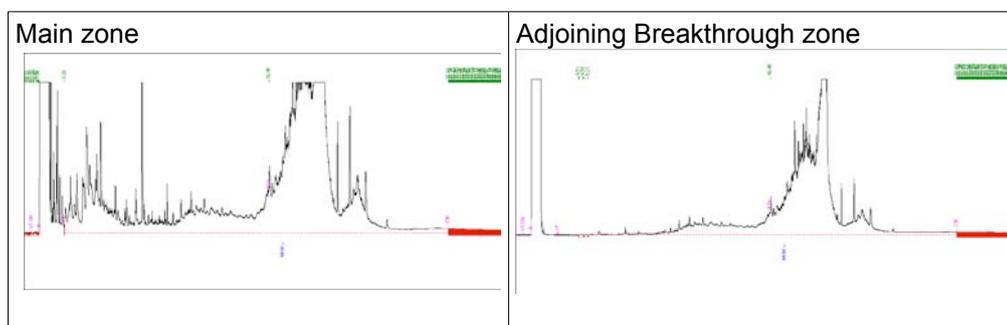


If the sampling has been done correctly, the major part of the substance will be found in the main zone. In the Chromatogram, it is also recognized that only short chain, volatile hydrocarbons are present. Long chain components (=lubricating oil) are almost negligible. The plant is in good condition.

The following Chromatogram shows the behaviour at breakthrough:

In the main zone, apart from the volatile short chain components, there is also long chain lubricating oil. It shows a distinctive "Lubricating oil hump" which suggests aerosol.

In the break-through zone, there is another picture: here almost no short chain components are found, instead, there are only long chain components. This is to be attributed to the fact that the short chained hydrocarbons were absorbed almost completely by the main zone with the given flow rate. The aerosols were also partly absorbed by the main zone, if these arrive there at the surface of the activated charcoal and remain "Glued". However, a part of the aerosol "Tunnel through" to the main zone and reaches the break-through zone. However, here also, only a small portion is absorbed, the remaining portion escapes. It is quite probable that the sum value is not correct. Since the KW portion is more than 25 % in the break-through zone, the result of sampling is to be rejected.



In the examples, it can be very well seen that both plant condition and errors in sampling can be interpreted on the basis of Chromatogram of main and break-through zone.

# RESIDUAL OIL SAMPLING

## 5.4.4 Application of sampling tubes

The main zone is longer of the two zones and the flow must pass through this first. Hence, the flow direction should be certainly taken care of.

Due to the low flow rate, the flow resistance practically plays no role. The contact time in the main zone should be approx. 0.1 sec as per the standard. Since the tubes are operated at plant pressure, the flow rate is proportional to the plant pressure. The possible range is 2l/min at 4 bar and up to 5l/min at 10 bar system pressure.

For safety reasons, you will get our sampling tubes inserted into a holder, which also serves as the splinter protection. The ends of the holder are closed and may be removed only at the beginning of sampling. After carrying out the sampling, the ends are to be closed again.

Remarks: For safety reasons, safety goggles should be worn during the activity!

## 5.5 Flow rate in sampling tubes

As mentioned earlier, the flow rate is decided by the predetermined contact time as per standard and system pressure.

The standard 8573-5 prescribes a retention time of 0.1 seconds in the Sorbiens. From this, the following maximum flow rate comes in the tubes used, based on the geometry:

System pressure	Flow rate l/min	Flow rate l/h
0 bar	4.7 l/min	282 l/h
4 bar	18.8 l/min	1128 l/h
6 bar	28.2 l/min	1692 l/h
10 bar	47 l/min	2820 l/h
16 bar	75.2 l/min	4512 l/h

The table is valid at 20 °C and 1000 mbar ambient pressure.

At the values specified in the table, the flow rate in the test tube is 1 m/sec (under pressure). Therefore, the tubes with appropriate cross section are also suitable for the Iso-kinetic sampling with a withdrawal lance (mounted in an upstream line with elbow).

The stainless steel sampling tubes are designed for upto 200 Bar pressure, because of which residual oil measurement in high pressure compressors is also possible. If you need the high pressure model, then please indicate this in the order!

# RESIDUAL OIL SAMPLING

## 5.6 Evaluation procedure

The procedure is based on the fact that a certain sample gas quantity flows through an absorbent. The hydrocarbons present in the air gets trapped in the Sorbiens. The hydrocarbons so absorbed in the Sorbiens are dissolved in the laboratory, analysed by gas chromatograph and the ingredients are determined. All hydrocarbons from C6 to approx. C40 are evaluated.

### 5.6.1 IR Spectroscopy (FTIR)

As per the standard ISO 8573-2:1996, TCTFE to be used as solvent for extraction, which is also known under the name Trichloroethylene or in short "Tri". The application of this solvent and the described FTIR procedure are no longer allowed as per applicable European Union-Directives due to the carcinogenic effect and should be no longer sold to the "End users". Hence, the very often used earlier FTIR procedures has lost its meaning in the last few years and it is more and more getting replaced by the Gas chromatograph.

The required analysis equipment is available in-house with us, however these are being used only on explicit customer request.

### 5.6.2 Gaschromatographic evaluation (GC-FID)

The evaluation is done with the help of so-called gas chromatography.

The used FID (Fleming Ionization Detector) enables linear measurement of the material concentrations.



Result of the evaluation shows an analysis of the total quantity and the distribution of the material composition/chain length over the retention time. However, the individual components are not identified.

Therefore, the evaluation is done as per the so-called H53 method, which is also used, for example, water or soil samples and is a valid substitute for the IR spectroscopy procedure.

In 2001, the applied H53 method replaced the till then common Method H18 as per DIN 38409. Reason is the European Union general prohibition of the used ozone depleting fluorine based solvents.

### 5.6.3 Mass spectroscopy

The mass spectroscopy is also a method of analysis by gas chromatography. It is one of the most flexible and most efficient methods of analysis and through the quantitative KW determination, it also enables the identification of material and quantitative determination of individual components.



# RESIDUAL OIL SAMPLING

## 5.7 Residual oil-Classes

As per ISO 8573-1, the following residual classes are defined

Residual oil Class	Residual oil content
0	$\ll 0.01 \text{ mg/m}^3$
1	$\leq 0.01 \text{ mg/m}^3$
2	$\leq 0.1 \text{ mg/m}^3$
3	$\leq 1 \text{ mg/m}^3$
4	$\leq 5 \text{ mg/m}^3$

Class 0 is user defined but better than Class 1

# RESIDUAL OIL SAMPLING

## 5.8 Characteristics of the GC-FID measuring procedure

The following data characterises the procedure developed by us with the help of GC-FID as per H53 method.

Detectable substances: Anything to bind organic materials in the range of C6 bis C40 through active charcoal

Detection limits            0.5 µg Hydrocarbons in Sorbiens

Desired loading            50 µg to 500 µg

Results from above:      0.001 mg/m<sup>3</sup> at 1l/min flow rate and 186 h sampling time

Analysis accuracy of GC    +/- 10 µg/ml at 250 µg/ml

## 5.9 Standard conditions

All results are with respect to standard conditions. These are defined in the standard ISO 8573-1 as follows:

Temperature: 20 °C

Pressure: 1000 mbar absolute

Relative humidity of gas flow: 0%

According to the gas setting, the results are referred to standard conditions. Accordingly, temperature and pressure are applied. The relative humidity does not play any role with respect to residual oil determination.

Die Korrektur der Ergebnisse erfolgt nach folgendem Zusammenhang:

$$c_{ref} = c_{test} * (p_{ref} / p_{test}) * (t_{test} / t_{ref})$$

$c_{ref}$       Material concentration at reference conditions

$c_{test}$      Material concentration at test conditions

$p_{ref}$      Pressure at reference conditions (as absolute pressure) = 1000 mbar a

$p_{test}$     Pressure at test conditions (as absolute pressure)

$t_{test}$     Test temperature (as absolute temperature in K)

$t_{ref}$      Reference Temperature (as absolute temperature in K) = 293.17 K

# RESIDUAL OIL SAMPLING

## 6 General information on application

### 6.1 Care and cleanliness

**Absolute cleanliness while using the measuring equipment is of utmost priority.** Contamination invariably leads to errors and distortion in measurement results.

### 6.2 Responsibility

The care during sampling considerably determines the reproducibility, accuracy and authenticity of measurement. The basic conditions mentioned in the standard 8573-5: 2001, should be maintained by the sampling person. The sampling person is responsible for correct execution of sampling. Therefore, the sampling must be carried out by only technically qualified persons.

Sampling report format is to be filled out carefully and completely. The measured values are to be measured and not estimated.

### 6.3 Inspection of plant

Before beginning of sampling, the plant is to be inspected. The details of most important components (compressor, filter, catalyst, activated charcoal absorber) are to be documented in report format, and in addition, the operation hours and last filter change are also to be noted.

In case of completely unknown condition of the plant, a rough determination with directly indicating sampling tubes (with colour change) to be carried out.

### 6.4 Location of sampling

In the sampling procedure for oil vapour described in this documentation, Iso-kinetic withdrawal is not necessary. Therefore, the connection can be done at any place in the compressed air network, so that the measuring point is meaningful in the proximity of compressed air supply, after the filter/absorber. The withdrawal must be done at a location, in which there would be no contamination due to oils or fats. Valve cocks or quick-couplers are often dirty or greased and therefore, they are rather unsuitable.

If the measurement is to be conducted recurrently, mounting of a withdrawal device is recommended.

### 6.5 Basic conditions

The operating pressure in the plant should be in the range of 4 to 10 bar and should be as constant as possible.

The flow is proportional to the pressure. The flow indicated on the flow meter by the floated element should be as constant as possible, also during the night period.

Therefore, during long duration sampling, the plant may not be switched off at night or on the weekend.

In case of pressure fluctuations, the flow rate should be set in between at 2000 ml/min. For pressures beyond 10 bar, the glass test tubes are not suitable. For this purpose, you can use our stainless steel test tubes.

The temperature during sampling should be ideally below 30°C, so that the activated charcoal has optimal absorption.

# RESIDUAL OIL SAMPLING

All ambient parameters (pressure in the plant, temperature, humidity and ambient pressure) must be documented in report format. Similarly, the dew point in the plant should also be documented.

## 6.6 Flow rate

The flow passes through Sorbiens under pressure. Since the retention time in Sorbiens increases with rising system pressure, sampling can be done with higher flow (with reference to standard conditions), with which the time for sampling clearly reduces.

Since, in most of the cases doing twice is necessary for the customer, in principle, we recommend to work with 2l/min flow rate. This minimizes the risk of a bad sampling and hence ensure an enrichment in the main zone instead. As per requirements of the standard, the test is to be discarded and the sampling is to be repeated, if more than 25% of the hydrocarbons are found in the backup zone. If the sample is taken too fast, the break-through zone is heavily loaded.

The standard 8573-5 prescribes a retention time of 0.1 seconds in the Sorbiens. From this, the following maximum flow rate comes in the tubes used, based on the geometry:

Plant pressure	Flow rate l/min	Flow rate l/h
4 bar	2 l/min	120 l/h
5 bar	2.5 l/min	150 l/h
6 bar	3 l/min	180 l/h
7 bar	3.5 l/min	210 l/h
8 bar	4 l/min	240 l/h
9 bar	4.5 l/min	270 l/h
10 bar	5 l/min	300 l/h

The table is valid at 20 °C and 1000 mbar ambient pressure.

## 6.7 Time span for sampling

The sampling time is to be adapted as per the assumed residual oil Class and adjusted flow rate. For an useful analysis in the laboratory, at least 50 µg hydrocarbons should be present in the Sorbiens but the maximum amount should not be more than 500 µg. However, if the analysing device goes into overflow, it is possible to dilute the sample. But, if there is too little quantity of material in the Sorbiens, the sampling is to be repeated to achieve useful results.

# RESIDUAL OIL SAMPLING

Based on above, following are the sample times corresponding to the residual oil class of the plant:

Residual oil Class	KW-Content	Flow rate at 2 l/min	Flow rate at 5 l/min
0	$\ll 0.01 \text{ mg/m}^3$	$> 417 \text{ h}$	$> 166 \text{ h}$ (approx. 7 days)
1	$\leq 0.01 \text{ mg/m}^3$	417 h (approx. 2.5 weeks)	166 h (approx. 7 days)
2	$\leq 0.1 \text{ mg/m}^3$	42 h (approx. 1.75 days)	17 h
3	$\leq 1 \text{ mg/m}^3$	4.15 h suitable condition	1.7 h suitable condition
4	$\leq 5 \text{ mg/m}^3$	unsuitable	unsuitable

For Class 3, the measuring procedure is suitable only if it is ensured that no aerosol is present in compressed air.

In Class 4, probably aerosol is present. In this case, The sampling must be done Iso-kinetic. Please get in touch with us in this respect.

## 6.8 Documentation of application and the results

The form for sampling is to be filled out carefully. Specially the plant pressure, ambient pressure and temperature are to be measured and recorded. For noting down pressure, the mention of Absolute/Relative pressure is also necessary. The conditions at the withdrawal point during sampling should be constant as far as possible, even for sampling over many days and also in the night time.

The form is to be completely filled out and signed by the person responsible for sampling. The signing person is responsible for the correct execution and conformity to the standard. The analysis in the laboratory is always with respect to the prepared sample.

## 6.9 Results

You can get the results within one week of sample submission. If desired, express delivery service (at extra charge) is also possible within 48 hours.

The shipping of original signed analysis report is done by post. If desired, a prior shipment by email or FAX is also possible with express delivery service.

# RESIDUAL OIL SAMPLING

## 7 Sampling

### 7.1 Preparation work

The rental sampling set is supplied in completely cleaned and passivated condition together with the sampling tubes. All components are passivated at works, i.e. the components are treated in such a way by thermal passivation so that these are absolutely oil and grease-free..

Cleanliness while working with the sampling tube and withdrawal pipe is therefore of utmost priority. Impurities, for example, touching with greasy hands, leads to distortion of measurement results! Therefore, perfectly clean the hands and put on safety hand gloves before beginning the work.

Please first prepare the system in office. Be familiar with the components and try out everything yourself.

### 7.2 Withdrawal location

The withdrawal location is to be carefully selected. It must be after the compressed air treatment stage and also after the Coalescence filter, dryers, and if necessary after the catalyst and activated charcoal absorber. The relative system pressure in the plant should be approx. 4-10 bar and the compressed air temperature should be approx. 25°C. In hotter environment, the absorption behaviour of active charcoal worsens, which leads to lower measured values and higher enrichment in the backup zone. Above 30°C, the flow rate should be reduced to 50% of the maximum values determined by calculation.

### 7.3 Withdrawal point

Equally important is the withdrawal point. If samples are to be analysed regularly, then it is suggested to install an outlet ball valve, which can be obtained from us as accessories. This ball valve offers safe, pollution free access to compressed air and this already available facility becomes useful for the next required measurement. The pressure dew point or the biological bacteria count can also be determined at the measuring point.

By following special installation guidelines, the withdrawal ball valve also becomes suitable for Iso-kinetic sampling.

### 7.4 Connection to a compressed air outlet

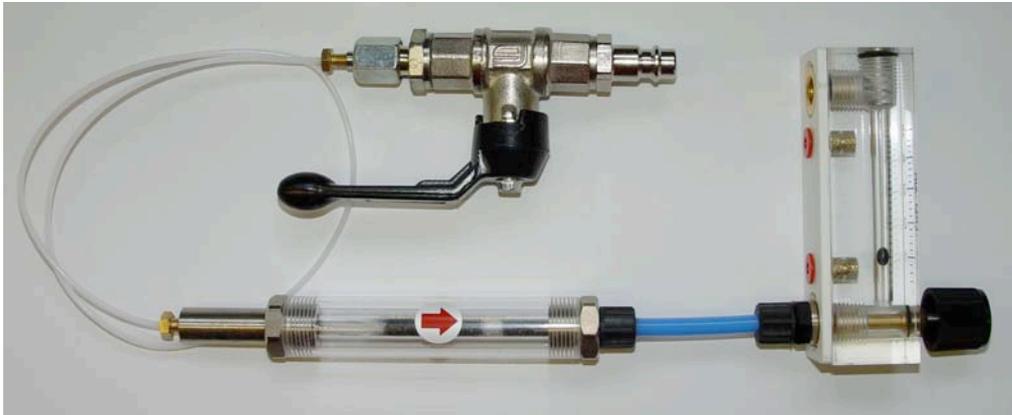
The withdrawal of sample over a quick-connection valve ("Compressed air coupling") is only recommended in exceptional cases. Due to the type of construction, contaminations are possible in this arrangement e.g. in the area of valve disc.

Only if the plant is considered aerosol free and measurements are carried out in the range of Class 1 or 2, the connection through a quick connection coupling is to be considered.

In this case the connection must face upwards and the valve must be kept open with higher flow rate for at least 5 minutes for "Free blowing" out.

# RESIDUAL OIL SAMPLING

## 7.5 Assembly of sampling set



## 7.6 Withdrawal lance

The provided withdrawal lance enables to take a sample without danger of contaminating the central part of the line. The withdrawal lance is sealed through the PTFE sleeve in the clamping ring connection and put in so that it is flexible to shift. After opening the ball valve, the lance is under pressure and can be introduced upto the centre of the compressed air stream in the line through the opened ball valve.

The withdrawal lance can also be used for Isokinetic withdrawal. Further information is available on request.

Note: The Teflon hose of the test gas-Samplers should not be stretched.

## 8 Operational sequence of sampling

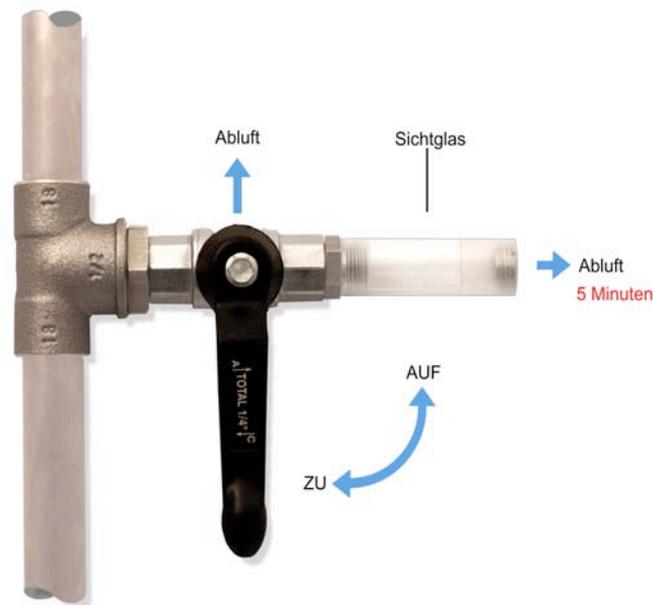
The system consists of the flow meter with needle valve, sampling tube and connection hose with withdrawal lance.

The sampling tube is closed on both sides with caps. The caps should be removed only just before the sampling and **must** be again put back after carrying out the sampling and before shipping to the laboratory.

### 8.1 Start of sampling

1. Select a suitable withdrawal point. If possible, mount any of the grease free ball valve supplied together. Mount the enclosed sight glass with muffler on the ball valve and cyclically open/close the valve cock. Allow the compressed air to release out for approx. 5 minutes and check whether any foreign particles, dust, dirt or condensate are visible on the sight glass. If this is the case, the sampling should be aborted and the plant should be set right.

# RESIDUAL OIL SAMPLING



2. Fasten the flow meter to the compressed air line, near the withdrawal point, with the provided cable binder. For further measurements, the flow meter must stand exactly vertical. Also fasten the sampling tube with a cable binder, so that the flow meter can be attached on one side of the hose and the hose reaches up to the ball valve with the clamping ring connector. The direction of flow should be essentially considered. There is an arrow on the sampling tube to indicate flow direction. The flow must first pass through the larger main zone.

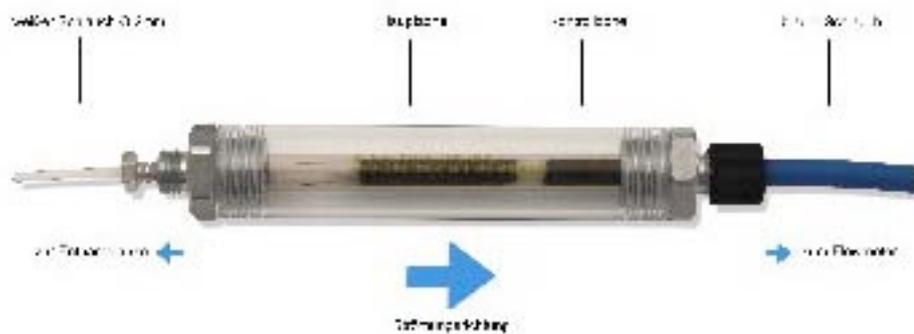
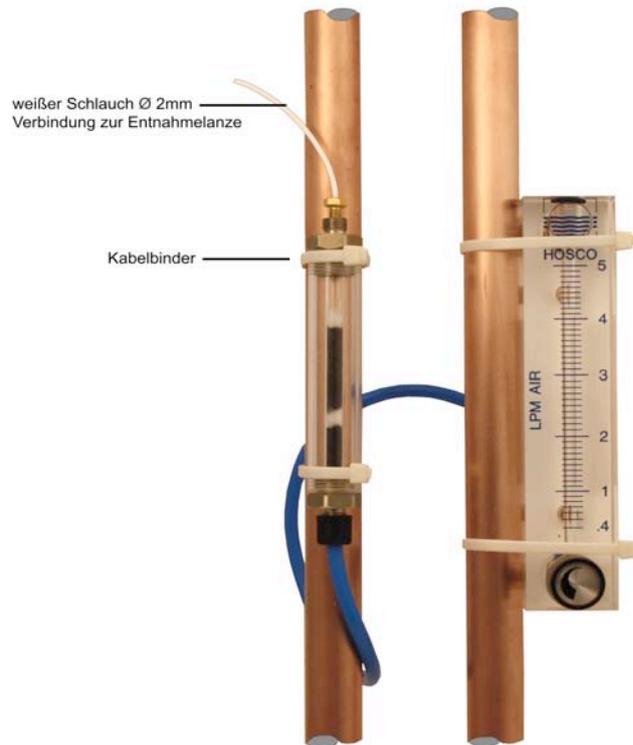


Abb: Prüfröhrchen mit Splitterschutz

# RESIDUAL OIL SAMPLING



3. Clean hands and put on rubber gloves.

4. Take out the sampling hose with clamping ring connector and the withdrawal lance from the packing bag. Screw the withdrawal lance on the ball valve. Tighten the union nut **by hand**. Then open the ball valve for approx. 5x cyclically.

**ATTENTION!** Tightly hold the other end of the sampling hose, so that it does not interfere!



# RESIDUAL OIL SAMPLING

Now keep the flow at around 2l/min on the flow meter by rotating the throttle in clockwise direction.

Important note: Keep checking the flow and system pressure in between. During fluctuations, the average value should be adjusted at 2 l/min.

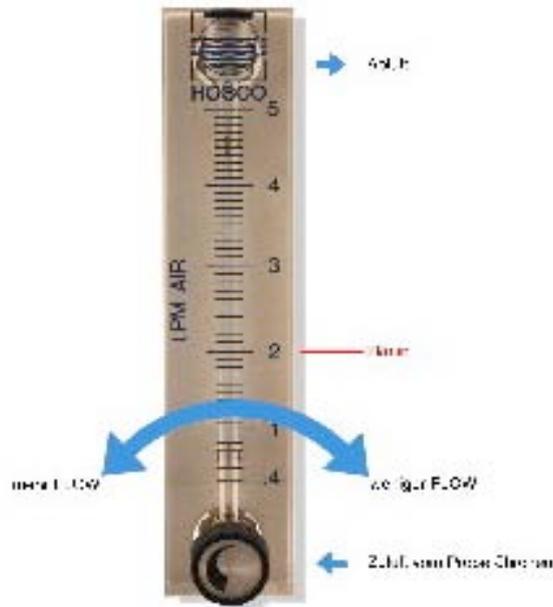


Abb: Flowmeter

7. **Essential Note:** Record the starting point with date and time, adjusted flow, temperature, ambient pressure, relative humidity and plant pressure on the report of sampling.

Also fill out the remaining fields of the report. Please carry all data because then only a complete test report can be prepared. In case of unknown information, please write down a line of comment.

With this, the first activity is over. Now wait for the time period required for sampling.

Residual oil Class	KW Content	Flow rate at 2 l/min	Flow rate at 5 l/min
0	<< 0.01 mg/m <sup>3</sup>	> 417 h	
1	<= 0.01 mg/m <sup>3</sup>	417 h (approx. 2.5 weeks)	166 h (approx. 7 days)
2	<= 0.1 mg/m <sup>3</sup>	42 h (approx. 1.75 days)	17 h
3	<= 1 mg/m <sup>3</sup>	4.15 h suitable condition	1.7 h suitable condition
4	<= 5mg/m <sup>3</sup>	unsuitable	unsuitable

# RESIDUAL OIL SAMPLING

## 8.2 Completion of sampling

1. Compulsory note: Again record the end point with date and time, current flow rate (average value), temperature, ambient pressure, relative humidity, and plant pressure in report of sampling withdrawal.
2. Close the ball valve and wait till the measuring set-up is pressureless.
3. Clean the hands and put on the rubber gloves.
4. Remove the hoses on both sides of the sampling tube. Get the cover caps from the minigrip bag and close back the sampling tube.
5. Insert the sample tube into the envelope provided and send them to our laboratory for analysis..
6. Dismantle the remaining parts of the sampling arrangement and place them back in the carry case. In case of rented equipment, please send back these parts to us together with the sample.
7. If the ball valve is to remain in the plant, the clamping ring connector must be closed with a teflon disc and union nut.

With this, the technical work is complete. Now comes some more office work: There is an EXCEL file in the enclosed memory stick. Please record all information in the file and also save the created file on the memory stick. Also keep a backup in your own working directory. Enclose the memory stick with the sample.

The return bag is already marked with our laboratory address.

No envelope or address label is required to send the sample at the following address:

**PRO air gmbH**  
**Analyselabor**  
**Peter-Müller Strasse 29a**  
**80997 München**

## 8.3 Analysis report

The analysis report is prepared as per the requirements of ISO 8573-5 and contains all relevant information. In addition, the Chromatogram of analysis and its calibration is also given with the documents.

# RESIDUAL OIL SAMPLING

Chemisches Labor

Analysen-Bericht Nr.  
analysis report no  
HYG-021302-001

Seite 2 von 13  
Page 2 of 13

## Auftragsbeschreibung

**Beschreibung der Messaufgabe** Quantitative Bestimmung des Kohlenwasserstoff-Gehalts in [ng/l] im Sorbiers mittels GC-FID  
Berechnung des Kohlenwasserstoff-Gehalts im Trägergas (Druckluft) in mg/m<sup>3</sup>  
Bestimmung der Stoffzusammensetzung (Screening) mittels GC-MS, quantitative Bestimmung der Inhaltsstoffe

Normen Bezug

ISO8573-5:2001

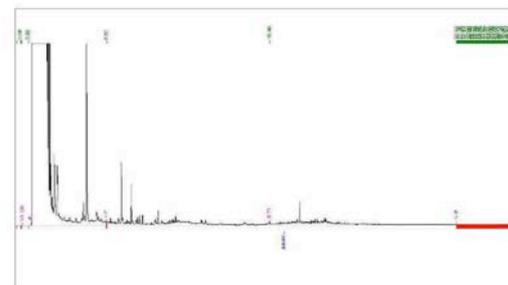
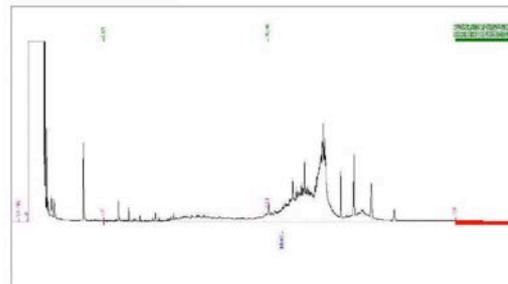
Chemisches Labor

Analysen-Bericht Nr.  
analysis report no  
HYG-021302-001

Seite 4 von 13  
Page 4 of 13

## Auswertungen

### Chromatogramm GC-FID



Gesamt KW in der Probe 50 µg/ml  
KW in der Druckluft 1,27 mg/m<sup>3</sup>

# RESIDUAL OIL SAMPLING

## 9 Detected Substances

With the help of GC-FID and GC-MS and application of active charcoal as Sorbiens, the following substances are to be detected together with other things:

### 9.1 Aliphatics

All Alkanes from C<sub>6</sub> (Hexane) to C<sub>40</sub> (Tetradecane), z.B. Cyclohexane, Cyclohexene, n-Decane, 1-Decene, n-Dodecane, n-Heptane, n-Hexadecan, n-Hexane, Methylcyclohexane, Methylcyclopentane, 2-Methylpentane, 3-Methylpentane, n-Nonane, 1-Octene, n-Octane, n-Pentadecane, n-Pentane, n-Tetradecane, n-Tridecane, n-Undecane

### 9.2 Alcohols

Allylalkohol, 1-Amylalkohol, 1-Butanol, 2-Butanol, iso-Butanol, Ethanol, 2-Ethyl-1-hexanol, 1-Hexanol, 1-Propanol, 2-Propanol,

### 9.3 Aromatics

Benzol, Ethylbenzol, Ethyltoluole, Methylstyrol, Naphthalin, iso-Propylbenzol, n-Propylbenzol, Styrol, Toluol, Trimethylbenzole, m-Xylol, o-Xylol, p-Xylol

### 9.4 Esters

2-Butoxyethylacetate, 1-Butylacetate, iso-Butylacetate, 1-Butylacrylate, 2-Ethoxyethylacetate, Ethylacetate, Ethylacrylate, 1-Methoxyethylacetate, 1-Methoxy-2-propylacetate, Methylacetate, Methylacrylate, Methylmethacrylate, n-Propylacetate, Vinylacetate

### 9.5 Halogen Hydrocarbons

Chlorbenzol, 1,2-Dichlorbenzol, 1,3-Dichlorbenzol, 1,4-Dichlorbenzol, 1,2-Dichlorethan, Dichlormethan, Epichlorhydrin, Freon R-113, Tetrachlorethen, 1,1,1-Trichlorethan, Trichlorethen, Trichlormethan

### 9.6 Ketones

Acetone, 2-Butanone, Cyclohexanone, Diisobutylketone, Isophorone, 5-Methyl-2-hexanone, Methylisobutylketone, 2-Pentanone

### 9.7 Nitrile Terpenes

Acetonitrile, Acrylnitrile, 3-Caren, Campher, Limonen,  $\alpha$ -Pinen,  $\beta$ -Pinen

### 9.8 Other VOC

1,3-Butadiene, Diethylether, 1,4-Dioxane, Tetrahydrofurane, 2-Pentylfurane

# RESIDUAL OIL SAMPLING

## 10 Order conditions

Our laboratory is accredited as per ISO 9001

We would carry out the analysis specified in the order as per the rules of technology. However, our responsibility is limited to the execution of analysis given by the client, and not the interpretation of results of our analysis. Similarly, we do not take guarantee for the correctness of the procedure, with which the client takes the samples to give us for analysis.

For damages, which can originate with respect to delivery and execution of order, we are only responsible if it can be proven due to rough negligence or done intentionally.

**Important Note: The application of solvents specified in the standard 8573-2 and the descriptive FTIR procedure are no longer allowed as per applicable EU-directives due to carcinogenic effect. Therefore the evaluation is done in our laboratory based on the so called H53 method, which is also used e.g., for water and oil sampling and as per state-of-the-art technology, it is a valid substitute for the IR spectroscopy procedure. To also capture the short chain components, we work with carbon disulphide solvent.**

# RESIDUAL OIL SAMPLING

The technical information in this document has been checked with adequate care at our end and is intended to inform about the product and its applications. The descriptions are not to be understood as assurance of the defined characteristics of the product and should be checked by the user for the intended application. Any possible third party patent rights are to be considered

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