VEDECKÉ PRÁCE

MATERIÁLOVOTECHNOLOGICKEJ FAKULTY SLOVENSKEJ TECHNICKEJ UNIVERZITY V BRATISLAVE SO SÍDLOM V TRNAVE

ČÍSLO 32
2012

RESEARCH PAPERS

FACULTY OF MATERIALS SCIENCE AND TECHNOLOGY SLOVAK UNIVERSITY OF TECHNOLOGY IN TRNAVA

NUMBER 32
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UNIVERZITA V BRATISLAVE
MATERIÁLOVOTECHNOLOGICKÁ
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2012 Number 32

PROPERTIES OF WATER MISCIBLE CUTTING FLUIDS IN THE CUTTING PROCESS

Eva BURANSKÁ, Peter POKORNÝ, Ivan BURANSKÝ

Abstract

Article discusses the diagnostics and possibility of monitoring cutting fluids and proposes a solution: on–line monitoring system. In regard to verify the possibility of using various methods to identify changes in the cutting fluids were carried out experiments to measure electrical parameters

Key words

cutting fluids, machining, properties, monitoring

Introduction

During machining, the cutting fluids are longer under the influence of their oxidation thermal and mechanical load, contamination and catalytic effects of metals. Various physical and chemical parameters are observed to consider the state of the cutting fluids (1). The main parameters are:

- value of pH, - concentration, - amount of bacteria, - temperature, - etc.

The operation control of aging of the cutting fluid must be simple. It is limited to the consideration of design and the smell of the surface which is washed with cutting fluid. The change of quality in emulsion fluids is the easiest to recognize. For the successful using of fluids regular monitoring and maintenance are important (3).

Control and diagnostics of cutting fluids

Today, diagnostics of cutting fluids can be classified according to the method and control periodicity into the following categories (1):

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a) no control – emulsion is used until there are no problems connected to the quality of workpieces, health problems of maintenance or damage to the machine,
b) simple operation without monitoring equipment – consideration of design, smell of fluid and look of surface which is washed with cutting fluid operation control:
  - laboratory control,
  - manual processing with monitoring equipment (e.g. manual optical refractometry, pH records, test for determination of water and nitrite hardness),
c) real –time control:
  - monitoring systems without feedback (modification of parameters is manual),
  - monitoring systems with feedback (modification of parameters is automated).

Fig. 1 shows the hierarchic arrangement of currently applied methods of control and monitoring of the state of cutting fluids. Also, today there are still companies which put the issues of cutting fluids in the last place and they do not pay attention to the control of their state. Simple operation control is very often implied and this cannot provide appropriate analysis of the cutting fluids properties. The larger companies apply the operative attitude (laboratory control), however this method is very slow, and in many cases, there are changes of sample properties from the moment when the sample was accepted and analyzed which can cause a faulty explanation of results. At the top of the hierarchy of currently applied methods of control and monitoring of cutting fluids state is the so-called real-time control which is based on on-line monitoring systems, which can evaluate the actual state of cutting fluids in real time and adopt the measurements for modification of measured properties.

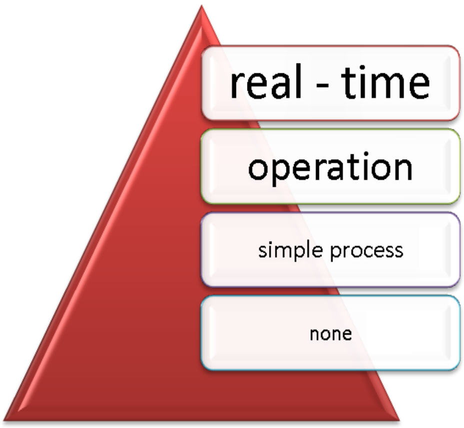

Fig. 1 *Hierarchy of methods for control of the cutting fluids state*

Online monitoring system

The main aim was to design our own on-line monitoring system, which differs from the existing ones in:

- the access to measurement method of the cutting fluids concentration,
- the concentration measurement is simpler,
- costs are lower.

Firstly, the most important parameters which could characterize the actual status of the fluid were defined. Based on the experiment of change defining selected parameters of cutting fluids, the following parameters were chosen:

- **Concentration** – a cooling effect sinks with the growth of the structure of the oil, tool life-cycle is reduced, foamability grows and an appropriate space for microorganism growth is created. So–called “tramp oils” can have a negative influence on the results. The optimal concentration of emulsion is conditioned by the concentrate character and cutting process. For measuring of cutting fluids concentration, electrical parameter of conductivity was used. The conductivity of emulsion measured in high frequencies depends on the concentration of emulsion; that means concentration is increased by a higher frequency (experiment of dependence defining specific electrical conductivity on concentration of cutting fluids).

- **pH** – parameter of pH is defined as the negative decadic logarithm of activity of oxygen cations. The labeling of the hydrogen exponent $pH = -\log C_H^+$ was implemented to define the grade of acidity or alkalinity. The acid range has the value $pH<7$, for a neutral solution $pH=7$, and alkaline solution has $pH>7$. The risk of skin irritation is higher with a growing pH; a decline of pH weakens anticorrosion protection and the danger to microorganisms and nitrosamines is increased.

The normal pH for emulsion is between 8.0 and 9.3. Cutting fluids containing amines have 8.5 as a lower limit, under which their functional properties are quickly worsened. Cutting fluids without amine can today work without problem at a pH of 8.0. In the case of decline of this value under 8, the emulsion should be conserved (or replaced).

- **Temperature** – the cooling effect sinks by the increase of temperature and an appropriate room for fast microorganism growth is created over 30 °C.

Determination of dependence between concentration and specific electrical conductivity

The conductivity method, based on measurement of solution conductivity, was selected for an indirect observation of the concentration of cutting fluids. The experiment was processed with using HIOKI 3522-50 device in frequency intervals from 0.1 to 100 000 Hz and by one direction field. This device is a fully automatic electrical bridge reaching measurement accuracy in dependence on the used measurement frequency and size of electrical resistance in an extent from 0.6 to 0.2 % (2). During the experiment, the sample of constant volume (fluid) was poured to a prepared glass container while the flat copper electrodes were used in all measurements (Fig. 2). Measurements were processed at the laboratory temperature. We recorded values of electrical resistance by sample R and also capacity of C sample. These parameters were especially used for the dimensions of the fluid sample in the container to determine specific values of electrical and dielectrical parameters: electrical conductivity, loss factor, real and imaginary part of complex permittivity, complex electrical module and impedance (1).

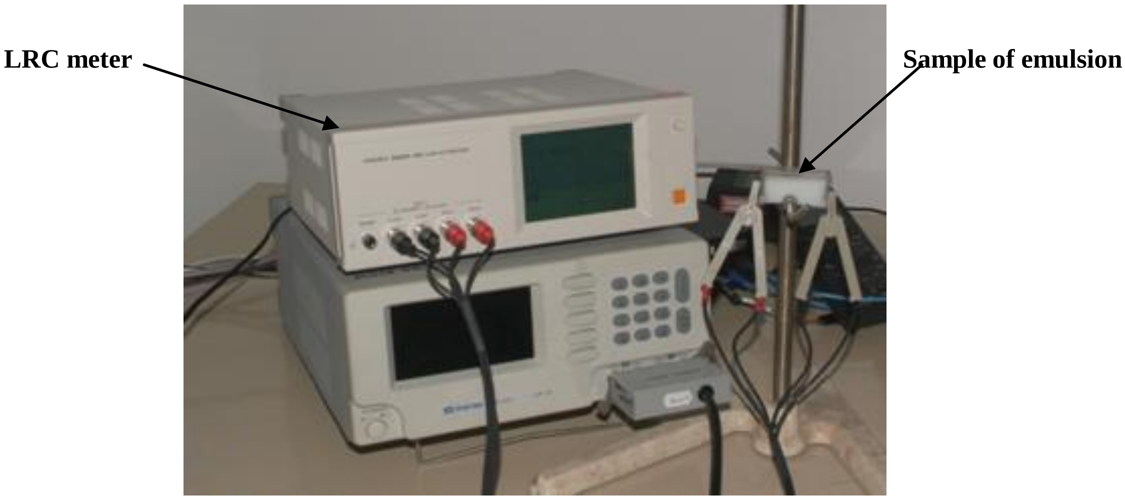

Fig. 2 *Measurement device for selected electrical parameters of cutting fluids*

The experiments showed that the highest sensibility of all sample groups were observed at a frequency of 100 000 Hz (Fig. 3 and Fig. 4).

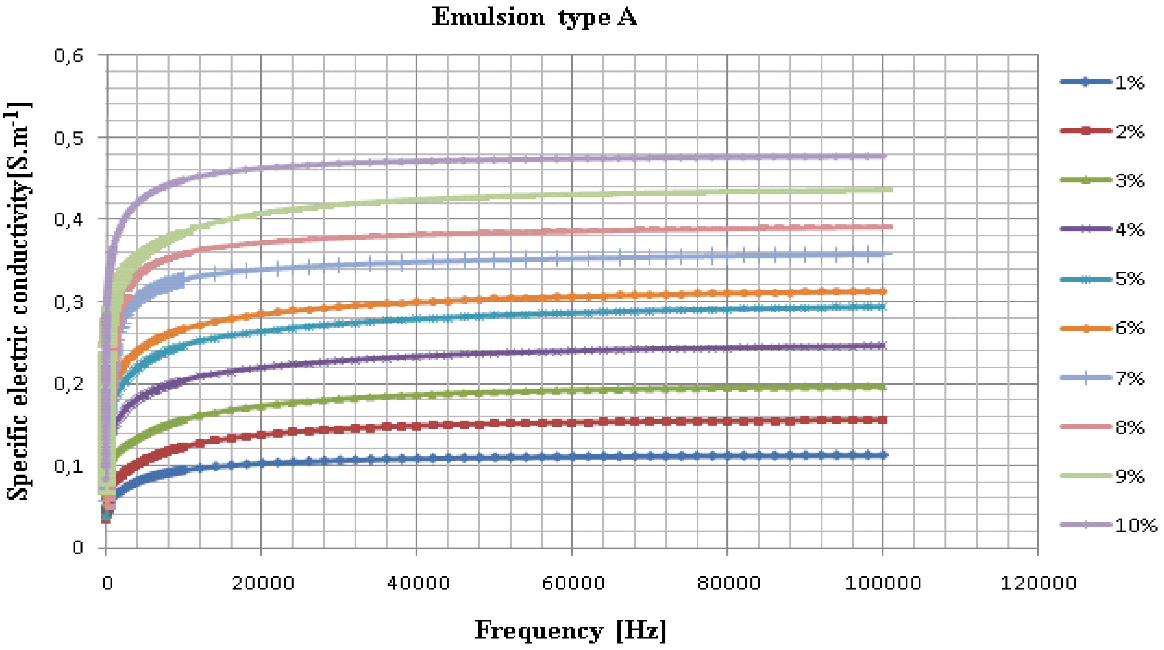

Fig. 3 *Dependence of conductivity on concentration of emulsion type A*

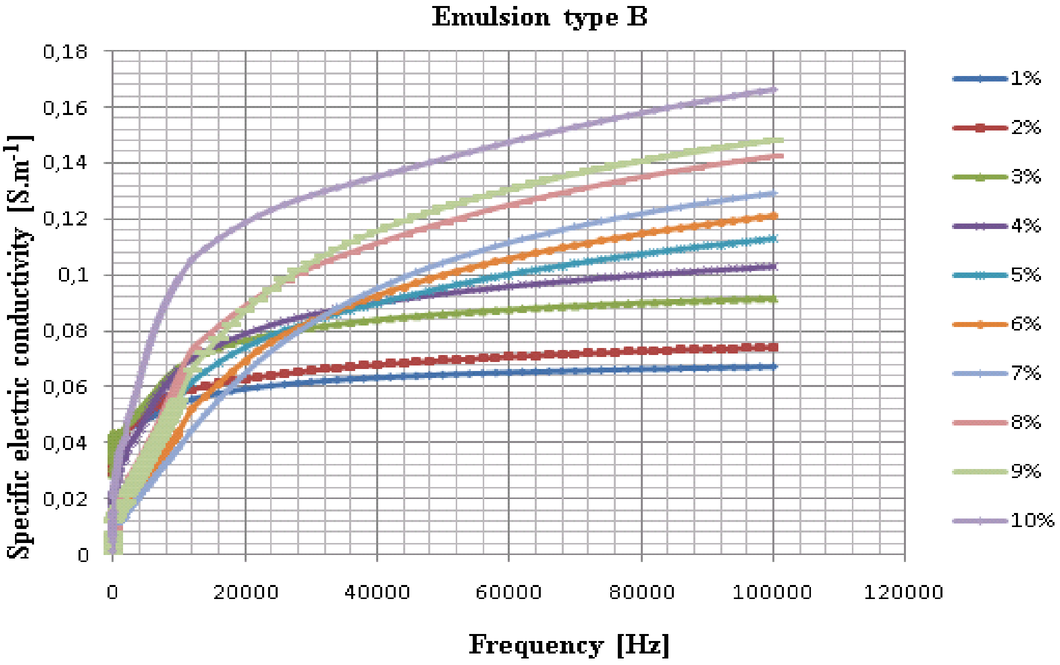

Fig. 4 *Dependence of conductivity on concentration of emulsion type B*

Fig. 5 shows there is linear dependence of specific electrical conductivity and concentration of cutting fluids at the high frequencies around 100kHz.

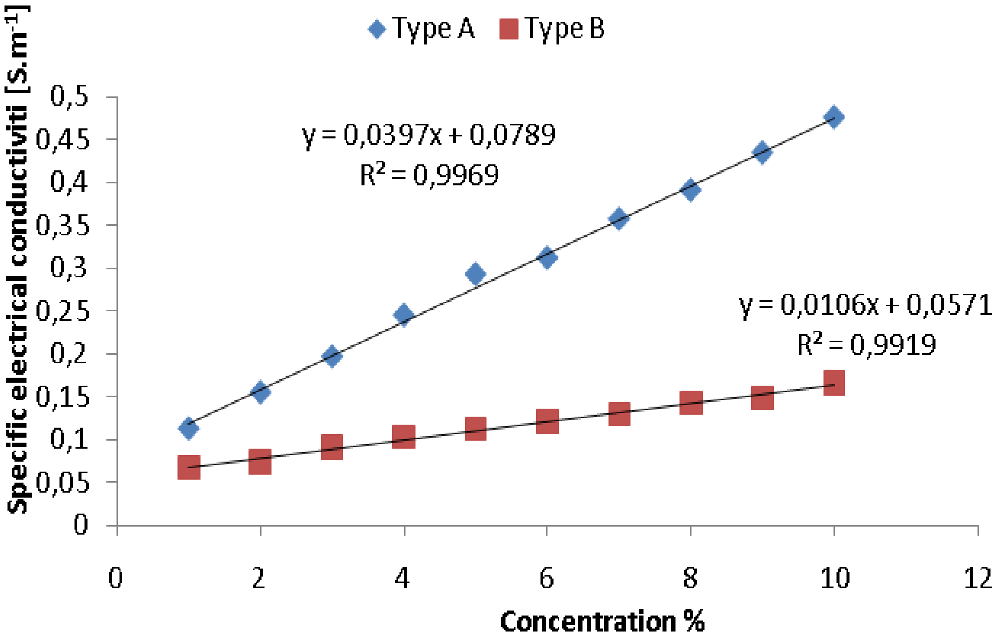

Fig. 5 *Dependence of specific electrical conductivity on concentration of emulsion type A and type B at frequency 100kHz*

On-line monitoring system

The system is formed with scanners of conductivity, pH, temperature and other measurement devices and PC with software which can evaluate the measured data in selected time intervals (1). The advantages of on-line monitoring system are that the measured data inform about actual states of cutting fluids, they show changes in real time which happen there, they enable the making of early modifications for efficient preservation of the properties of cutting fluids, and it will prevent an accelerated degradation of fluids, the loss of their capacity, and consumption and operation cost will be reduced. These and other aims and advantages of this system will be visible from the following description of the block scheme in Fig. 6.

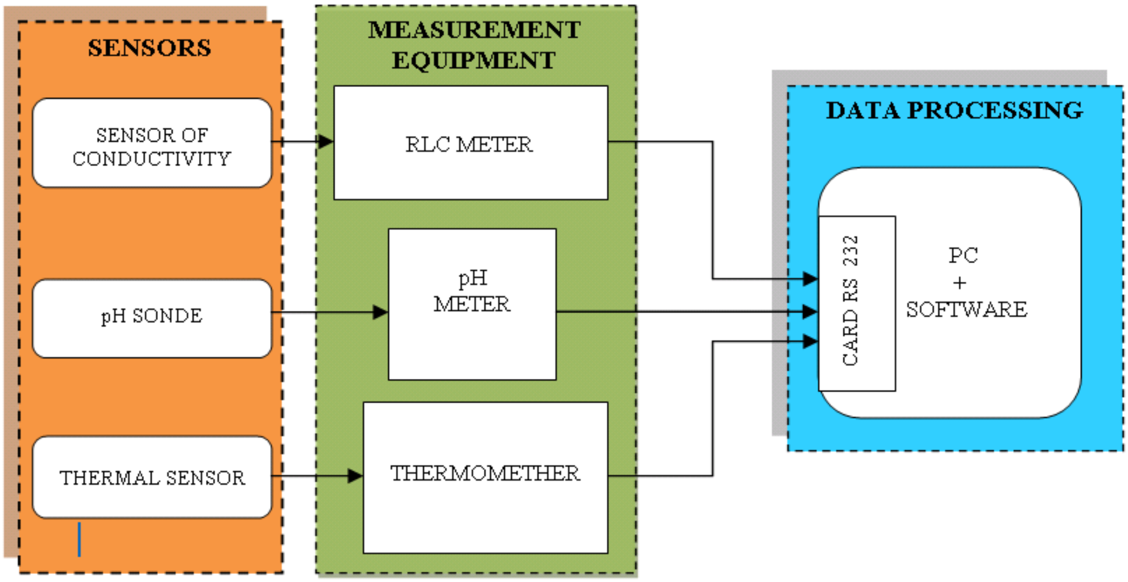

Fig. 6 *The block scheme of the on-line monitoring system*

The central monitoring system unit formed with sensors located in the container with the cutting fluid and regulation unit can be connected with PC and software processing measured values via Internet in or out of controlling room. Sensors can be located individually into every machining device or into a central distribution container of cutting fluids. The last possibility is to apply a monitoring system of fluid together with software and regulation units system of machine. This way provides a control of cutting fluids status to operation worker with which he/she works right now or will work.

Summary

Cutting fluids play an important role in engineering operation, and therefore it is very important to use fluids with good properties, conditions and to known the changes which proceed in the system and the causes of their formation. Monitoring system which is described in this article is simple to use and allows to reduce changes of fluids properties,and improve production with reduction of cutting fluids waste.

Acknowledgements

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ENGINEERING

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COMPARISON OF TWO SPECTROPHOTOMETRIC TECHNIQUES FOR NUTRIENTS ANALYSES IN WATER SAMPLES

Alica BARTOŠOVÁ, Anna MICHALÍKOVÁ, Maroš SIROTIAK,
Maroš SOLDÁN

Abstract

The aim of this contribution is to compare two common techniques for determining the concentrations of nitrate, nitrite, ammonium and phosphates in surface water and groundwater. Excess of these nutrients in water can directly affect human health (e.g. methemoglobinaemia) or indirectly through the products of secondary pollution – eutrophication (e.g. cyanotoxins, emanation of hydrogen sulphide, mercaptanes, methane...). Negative impact of nutrients excess in surface water often causes the destruction of water ecosystems, and therefore, common substances of these elements must be monitored and managed. For these experiments two spectrophotometric techniques - ultraviolet spectrophotometry and nutrient photometry were used. These techniques are commonly used for quick and simple analyses of nutrients in waste water. There are calibration curves for each nutrient and for determination of their concentration.

Key words

Monitoring of nutrients, surface water, spectrophotometric methods

Introduction

The term "nutrients" refers broadly to those chemical elements essential for life on earth, but more specifically to nitrogen (N) and phosphorus (P) in a water pollution context. Nitrogen is the most abundant element in air, but occurs in a form (N_2) unusable for most life forms. Since nitrogen is an abundant component of biological tissue, any organic matter in water will contain nitrogen. However, until these larger organic molecules are decomposed by bacteria, they are of little or no use for algae or other aquatic plants. Nitrogen is readily utilized by aquatic plants (such as algae) if it is dissolved in the water in an inorganic form:

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chemicals that are combinations of nitrogen and oxygen (nitrates NO_3^- and nitrites NO_2^-) or nitrogen and hydrogen (ammonium cations NH_4^+). It has the potential to adversely affect the health of infants and livestock. Surface water quality is the concern with phosphorus, as runoff and erosion from cropland add nutrients to water bodies that stimulate the excessive growth of aquatic weeds and algae. Of all crop nutrients, it is critical to prevent P from reaching lakes and streams since the biological productivity of aquatic plants and algae in fresh water environments is usually limited by this nutrient. The element phosphorus can occur in nature in many forms, but the most abundant dissolved inorganic form in aquatic environments is as orthophosphate (PO_4^{3-}). Consequences of the increased aquatic plant and algae growth (eutrophication) include reduced aesthetic and recreational value of lakes and streams as well as the seasonal depletion of the water dissolved oxygen content, which may result in fish kills as well as other ecosystem disruptions (1).

Nutrients need to be managed properly to meet the fertility requirements of crops without adversely affecting the quality of water resources. Methods for measuring the P and N forms in natural waters differ largely (Table 1), but the simplest is a chemometric method, which can colour the sample in dependence of nutrient concentration. The intensity of colour can be measured by comparison with standard scale (e.g. striped tests) or using the terrain or laboratory spectrophotometer.

POSSIBILITIES OF METHODS FOR NUTRIENTS DETERMINATION IN WATER SAMPLES (1, 5) Table 1

Analyte	**Methodology**	**Method**
Nitrogen ions	Ion chromatography	Standard method: 4110 Determination of Anions by Ion Chromatography
	UV Spectrometry method	STN ISO 7890-3 (75 7455): Water quality. Determination of nitrate. Part 3: Spectrometric method using sulfosalicylic acid
	UV Spectrometry method	STN EN 26777 (75 7438): Water quality. Determination of nitrite. Molecular absorption spectrometric method
	Titration	STN EN 25663: Water quality. Determination of Kjeldahl nitrogen. Method after mineralization with selenium.
	Colorimetric	EPA 353.1: Nitrate-Nitrite by Colorimetry. Official Name: Nitrogen, Nitrate-Nitrite (Colorimetric, Automated Hydrazine Reduction)
		EPA 353.2: Nitrate-Nitrite Nitrogen by Colorimetry. Official Name: Nitrogen, Nitrate-Nitrite (Colorimetric, Automated, Cadmium Reduction)
Phosphate ions	Colorimetric	EPA 365.1: Phosphorus (all forms) by Semi-Automated Colorimetry. Official Name: Phosphorus, All Forms (Colorimetric, Automated, Ascorbic Acid)
	Ion chromatography	Standard method: 4110 Determination of Anions by Ion Chromatography
	UV Spectrometry method	STN EN ISO 6878 (75 7465): Water quality - Determination of phosphorus - Ammonium molybdate spectrometric method (ISO 6878:2004)
	Gas chromatography-mass spectrometry	EPA Method 507: Determination of Nitrogen- and Phosphorus-Containing Pesticides in Water by Gas Chromatography with a Nitrogen-Phosphorus Detector - Revision 2.1.
	Spectrofluorimetric method	USGS Test Method I-2464-01Organic plus Inorganic Mercury in Filtered Natural Water by Cold-Vapor AFS. Official Name: Methods of Analysis by the U.S. Geological Survey National

		Water Quality Laboratory - Determination of Organic Plus Inorganic Mercury in Filtered and Unfiltered Natural-Water with CV-AFS

Materials and methods

All of the experiments were performed according to the STN standards with solutions prepared from p.a. chemicals, using two spectrophotometers:

- Spectrophotometer TermoSpectronic^{TM}
- HANNAHI 83215 multiparameter bench photometer for Nutrient analyses.

A detailed description of the methods used is reported in the following session.

Fig. 1 *Spectrophotometer TermoSpectronic GENESIS^{TM} and HANNA HI 83215 Spectrophotometer*

Nitrates - The analysis is based on the reaction of nitrate with sodium salicylate in a sulphuric acid medium, which formed yellow coloured salts of nitrosalicylic acid. Interference may be caused by ammonia and amines (as urea and primary aliphatic amines), chloride above 100 mg/L, chlorine above 2 mg/L, copper, iron (III), strong oxidizing and reducing substances. Sulphide must be absent (3, 4).

<u>Technique 1: Spectrophotometric determination of nitrate by sodium salicylate (0.1–20 mg/L) according to the STN ISO 7890-3 (75 7455) standard</u>

- Apparatus: Spectrophotometer TermoSpectronic GENESIS^{TM}, cuvette (5 cm), evaporating dish, boiler
- Reagents: *sodium salicylate* (0.5% water solutions, prepared freshly), sulphuric acid (conc. 96%, CentralChem), *sodium hydroxide* (c(NaOH) = 10 mol/L: 400 g NaOH is dissolved in distilled water in 1000 mL volumetric flask), *potassium nitrate* (c(NO_3^-) = 100mg/L – stock solution: 0.1631 g KNO_3 is dried in temperature 105°C and dissolved in 1000 mL distilled water in volumetric flask).
- Procedure:
  1. 10 mL water samples (solutions in concentration range) with 1 mL sodium salicylate are evaporated in an evaporating dish,
  2. after cooling down, add 1 mL of concentrated H_2SO_4, so that way the entire residue dehumidified and allowed to stand for 10 minutes,

3. quantitatively transfer it to a 50 ml volumetric flask,
4. add 7 mL NaOH and, after cooling to room temperature, adjust the volume to 50 mL with distilled water,
5. after 10 minutes, the stain remains and the absorbance is measured at 410 nm against a blank prepared in the same way (2, 3).

- Data to construct the calibration curves, using a standard solution of KNO_3 100 mg/L are shown in Table 2.

DATA NECESSARY TO CONSTRUCT THE CALIBRATION CURVES Table 2

$c(NO_3^-)$[mg/L]	**2**	**4**	**6**	**8**	**10**	**15**	**20**
V_1[mL]	1.0	2.0	3.0	4.0	5.0	7.5	10.0
V[mL]	50	50	50	50	50	50	50

Technique 2: Determination of nitrate using Nutrient Analysis Photometer

- Apparatus: Spectrophotometer HANNA HI 83215 Spectrophotometer, cuvette
- Reagents: *HI 93728* (cadmium powder <5%, sulfanilic acid <5%)
- Procedure:
  1. Select the "Nitrate LR" method (LR means Low range: 0 – 30.0 mg/L, e.g. irrigation water), "Nitrate MR" method (MR means Medium range: 0 – 150 mg/L, e.g. nutrient solutions, sample must be prepared by mixing 20 mL of testing solution and 80 ml of demineralized water) or "Nitrate HR" method (HR means High range: 0 – 300 mg/L, e.g. nutrient solutions, sample must be prepared by mixing 10 mL of testing solution and 90 ml of demineralized water).
  2. Fill the cuvette with 6 ml of sample up to half of its height, and replace the cap.
  3. Place the cuvette into the holder and close the lid. Press the Zero key. The display shows "-0.0-" when the meter is zeroed and ready for measurement.
  4. Remove the cuvette and add the content of one pocket of HI 93728-0 reagent. Replace the cap and immediately shake vigorously up and down for exactly 10 seconds. Continue to mix by inverting the cuvette gently for 50 seconds, while avoiding to induce air bubbles. Powder will not completely dissolve. The time and way of shaking could sensitively affect the measurement.
  5. Reinsert the cuvette into the instrument, without shaking it. Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 4 minutes and 30 seconds and press Read. When the timer ends, the meter will perform the reading. The instrument displays the results in mg/L of nitrate-nitrogen (4).

Nitrites - The analysis is based on the reaction of nitrites present in the sample with sulfanilicacid and α-naphtylamine to form a red-violet colour. The course of the reaction depends on pH (3, 4).

Technique 1: Spectrophotometric determination of nitrite ions by sulphanilic acid andα-naphylamine according to standard STN EN 26777 (75 7438)

- Apparatus: TermoSpectronic GENESIS^{TM}, cuvette (5 cm)
- Reagents: *sulphanilic acid* (0.6 % solution: 6 g of sulphanilic acid is dissoluble in750 mL of hot distilled water and add 250 mL of acetic acid), α – *naphtylamine* (0.6 % solution:

0.6 g of α - naphtylamine is dissolubled in distilled water while heating and stirring, add 25 mL of acetic acid and the solution is made up to 100 mL. Solution is sensitive to light and is stable for 2-3 months.), *sodium nitrite* (c (NO_2^-) = 100 mg/L – stock solution: 0.1497 g of $NaNO_2$ is dried in temperature 105°C and dissolved in 1000 mL; dilutions c (NO_2^-) = 10 mg/L: 10 mL of stock solution is added to a 100 mL volumetric flask with distilled water to final volume).

- Procedure:
  1. to 50 ml of the sample of water (or solution in concentration range supplemented distilled water 50 ml), 1 ml of sulfanilic acid was added and mixed,
  2. after 5 minutes, add 1 ml of α - naphtylamine and mixed,
  3. after 40 minutes the absorbance at 520 nm is measured against a blank prepared in the same way (2, 3).
- Data to construct the calibration curves, using a standard solution of $NaNO_2$ with concentration 10 mg/L are shown in Table 3.

DATA NECESSARY TO CONSTRUCT THE CALIBRATION CURVES Table 3

c(NO_2^-)[mg/L]	**0.1**	**0.15**	**0.2**	**0.25**	**0.4**	**0.45**	**0.5**	**0.6**
V_1[mL]	1.0	1.5	2.0	2.5	4.0	4.5	5.0	6.0
V[mL]	50	50	50	50	50	50	50	50

Ammonium cations - The analysis is based on the reaction of ammonium ions with Nessler reagent, which form a yellow-brown compound. Interference may be caused by: acetone, alcohols, aldehydes, glycine, and hardness above 1 g/L, iron, organic chloramines, sulphide, and various aliphatic and aromatic amines.

Technique 1: Spectrophotometric determination of ammonium cations by Nessler reagent according to the STN ISO 7150-1 (75 7451) standard

- Apparatus: Spectrophotometer TermoSpectronic GENESIS™ Spectrophotometer, cuvette (5 cm)
- Reagents: *Nessler reagent* (mercuryiodide 3%, potassiumiodide 3.5%, sodium hydroxide 12% and water 81.5%), *potassium sodium tartrate* (also called Seignett salt – $C_4H_4KNaO_6.4H_2O$, 50% solution), *ammonium chloride* (c (NH_4^+) = 100 mg/L – stock solution: 0.2965 g of NH_4Cl is dried in temperature 105°C and dissolved in1000 mL; dilutions c (NH_4^+) = 5 mg/L: 5 mL of stock solution is added to a 100 mL volumetric flask with distilled water to final volume).
- Procedure:
  1. to 50 ml of the sample of water (or solution in concentration range supplemented distilled water 50 ml), 1 ml of Seignett salt was added and mixed,
  2. after few minutes, add 1 ml of Nessler reagent and mix,
  3. after 10 minutes, the absorbance at 425 nm is measured against a blank prepared in the same way (2, 3).
- Data to construct the calibration curves, using a standard solution of NH_4Cl with concentration 5 mg/L are shown in Table 4.

DATA NECESSARY TO CONSTRUCT THE CALIBRATION CURVES Table 4

$c(NH_4^+)$[mg/L]	**0.05**	**0.10**	**0.20**	**0.40**	**0.60**	**0.80**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**4.00**
V_1[mL]	0.5	1.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	25.0	30.0	40.0
V[mL]	50	50	50	50	50	50	50	50	50	50	50	50

Technique 2: Determination of ammonia using Nutrient Analysis Photometer

- Apparatus: Spectrophotometer HANNA HI 83215, cuvette
- Reagents: *HI 93715A-0* (Nessler reagent: mercury iodide <10%, potassium iodide <10%, sodium hydroxide <20%), *HI 93715B-0* (potassium sodium tartrate <50%)
- Procedure:
  1. Select the "Ammonia LR" method (LR means Low range: 0 – 10.0 mg/L, e.g. irrigation water), "Ammonia MR" method (MR means Medium range: 0 – 50 mg/L, e.g. nutrient solutions, sample must be prepared by mixing 20 mL of testing solution and 80 ml of demineralized water) or "Ammonia HR" method (HR means High range: 0 – 100 mg/L, e.g. nutrient solutions, sample must be prepared by mixing 10 mL of testing solution and 90 mL of demineralized water).
  2. Fill the cuvette with 10 ml of sample up to mark, and replace the cap.
  3. Place the cuvette into the holder and close the lid. Press the Zero key. The display shows"-0.0-" when the meter is zeroed and ready for measurement.
  4. Remove the cuvette. Add 4 drops of HI 93715A-0 First Reagent. Replace the cap and mix the solution by inverting the cuvette a couple of times. Add 4 drops of HI 93715B-0 Second Reagent. Replace the cap and mix the solution by inverting the cuvette a couple of times.
  5. Reinsert the cuvette into the instrument. Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 3 minutes and 30 seconds and press Read. When the timer ends, the meter will perform the reading. The instrument displays the results in mg/L of ammonia nitrogen (4).

Phosphates - The analysis is based on the reaction of ammonium molybdate with orthophosphate ions to phosphomolybdic acid. This is reduced to molybdenum blue. Interference may be caused by: sulphide, chloride above 150 g/L, calcium above 10 g/L as $CaCO_3$, magnesium above 40 g/L as $MgCO_3$, ferrous iron above 100 mg/L (3, 4).

Technique 1: Spectrophotometric determination of phosphate ion PO_4^{3-} by Molybdenum blue method according to STN EN ISO 6878 (75 7465)

- Apparatus: Spectrophotometer TermoSpectronic GENESIS^{TM}, cuvette (5 cm)
- Reagents: *sulphuric acid* (c (H_2SO_4) = 2.5 mol/L: 140 mL of H_2SO_4 concentrate is dissoluble in 2000 mL flask bank in 800mL of distilled water. Prepare solution on ice to chill, adjust the volume to 2000 mL with distilled water), *ammonium molybdate* (15 g of ammonium molybdate $(NH_4)_6Mo_7O_{24}.4H_2O$ is dissoluble in 500 mL volume flask in distilled water), *potassium antimonyltartrate* (0.68 g of potassium antimonyl tartrate hemihydrate $K(SbO)C_4H_4O_6.1/2H_2O$ is dissoluble in distilled water in500 mL volumetric flask), *ascorbic acid* (2.16 g of ascorbic acid is dissoluble in distilled water in 100 mL volumetric flask), *mixed agent* (mixed agent is prepared only in the required amount before use. It is a mixture of 125 mL of H_2SO_4, 50 mL of ammonium molybdate, 25 mL of potassium antimonyl tartrate hemihydrate and 50 mL of ascorbic acid. Reagent is stable for about 4 hours.), *potassium dihydrogenphosphate* ($c(PO_4^{3-})$ = 500 mg/L – stock

solutions: 0.7165 g of KH_2PO_4 - dried for two hours to 105°C, is dissoluble in distilled water in 1000 mL volumetric flask).

- Procedure:
    1. to 50 ml of the sample of water (or solution in concentration range supplemented distilled water to 50 ml) was added to 100 mL Erlenmeyer flask,
    2. add 5 ml of mixed agent and mix,
    3. absorbance measured at 690 nm against a blank prepared in the same way (2, 3).
- Data to construct the calibration curves, using a standard solution of KH_2PO_4 with concentration 500 mg/L are shown in Table 5.

DATA NECESSARY TO CONSTRUCT THE CALIBRATION CURVES Table 5

c(PO_3^{4-})[mg/L]	**0.01**	**0.02**	**0.40**	**0.10**	**0.20**	**0.40**	**0.80**
V_1[mL]	0.5	1.0	2.0	5.0	10.0	20.0	40.0
V[mL]	50	50	50	50	50	50	50

Technique 2: Determination of phosphorus using Nutrient Analysis Photometer

- Apparatus: Spectrophotometer HANNA HI 83215, cuvette
- Reagents: *HI 93706A-0* (sulphuric acid < 75%, ammonium molybdenate < 7%), *HI 93706B-0* (dimethylformamide < 40%, di-sodium disulphide < 10%)
- Procedure:
    1. Select the "Phosphorus LR" method (LR means Low range: 0 – 10.0 mg/L, e.g. irrigation water), " Phosphorus MR" method (MR means Medium range: 0 – 50.0 mg/L, e.g. nutrient solutions, sample must be prepared by mixing 20 mL of testing solution and 80 ml of demineralized water) or " Phosphorus HR" method (HR means High range: 0 – 100 mg/L, e.g. nutrient solutions, sample must be prepared by mixing 10 mL of testing solution and 90 ml of demineralized water).
    2. Fill the cuvette with 10 ml of sample up to mark, and replace the cap.
    3. Place the cuvette into the holder and close the lid. Press the Zero key. The display show "-0.0-" when the meter is zeroed and ready for measurement.
    4. Remove the cuvette. Add 10 drops of HI 93706A-0. Add the content of one packet of HI 93706B-0 Phosphorus Reagent B to the cuvette. Replace the cap and shake gently until completely dissolved.
    5. Reinsert the cuvette into the instrument. Press Timer and the display will show the countdown prior to the measurement or, alternatively, wait for 5 minutes and press Read. When the timer ends, the meter will perform the reading. The instrument displays the results in mg/L of phosphorus (P) (4).

Results and discussion

Nitrates (NO_3^-) are often reported in all types of water. They are a final biochemical oxidation product of organically bound and nitrogen may be the evidence of contamination of organic origin by their greater concentration in natural waters. The surface water is related to the degree of nitrate eutrophication of these waters. Nitrates are therefore an important indicator of a fundamental analysis of surface water, both for quality control as well as in important assays NO_3^- (5). For spectrophotometric determination of nitrate by sodium salicylate according to standard STN ISO 7890-3 (75 7455), a calibration curve relating absorbance to concentration of nitrate nitrogen and a calibration curve of absorbance to nitrate concentrations were plotted (Fig. 2). The obtained equations are:

$$\text{N-NO}_3^-: \quad A = 0.6885 \times c \quad R^2 = 0.9930$$
$$\text{NO}_3^-: \quad A = 0.1555 \times c \quad R^2 = 0.9930$$

where *A* is absorbance and *c* is concentration (mg/L). The measured values of absorbance of NO_3^-concentration are available in Table 6.

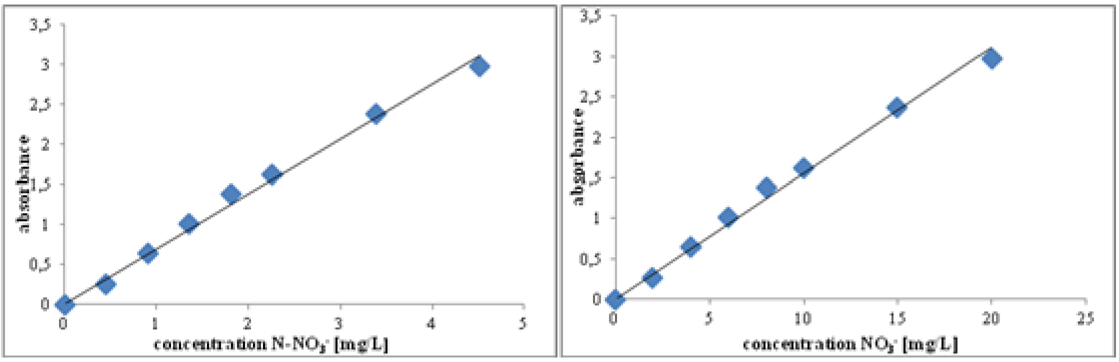

Fig. 2 *The calibration curve of relating absorbance to concentration of N-$NO_3^-$and NO_3^-*

THE MEASURED VALUES RELATING ABSORBANCE OF NO_3^- Table 6

c(N-NO_3^-)[mg/L]	c(NO_3^-)[mg/L]	A_1	A_2	A_3	$A_{average}$
0	0	0	0	0	0
0.452	2.000	0.259	0.259	0.262	0.260
0.904	4.000	0.642	0.649	0.639	0.643
1.356	6.000	1.020	0.957	1.057	1.011
1.807	8.000	1.400	1.342	1.403	1.381
2.259	10.000	1.609	1.633	1.610	1.617
3.389	15.000	2.379	2.392	2.340	2.370
4.518	20.000	2.974	2.963	2.989	2.975

The measurement of nitrates using HI 83215 instrument (Technique 2) is much easier, particularly suitable for the expected higher concentrations (e.g. in eutrophic surface water), which, in using traditional technique 1, would have to be strongly diluted. Technique 2 eliminates time–consuming evaporation of the sample with a mixture of sodium salicylate. On the other hand, classical Technique 1 is more suitable for the accurate determination of the expected lower nitrate concentration (e.g. in groundwater).

Nitrites (NO_2^-) can be found in surface water and in groundwater. Concentrations of nitrite ions are normally low, but high concentration may indicate the presence of pathogenic bacteria. They are therefore used as an indicator that water is not safe to drink (5). For spectrophotometric determination of nitrite ions by sulphanilic acid and α-naphtylamine according to the STN EN 26777 (75 7438) standard, a calibration curve relating absorbance to concentration of nitrate nitrogen and a calibration curve of absorbance to nitrate concentrations were plotted (Fig. 3). The obtained equations are:

$N\text{-}NO_2^-$: $A = 21.6860 \times c$ $R^2 = 0.9766$

NO_2^-: $A = 6.6058 \times c$ $R^2 = 0.9766$

where A is absorbance and c is concentration (mg/L). The measured values relating absorbance to NO_2^- concentration are available in Table 7.

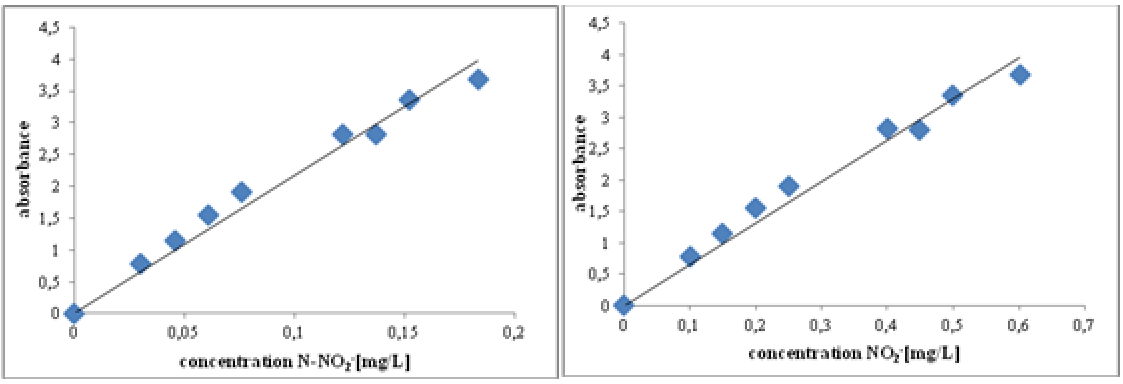

Fig. 3 *The calibration curve relating absorbance to concentration of* $N\text{-}NO_2^-$ *and* NO_2^-

THE MEASURED VALUES RELATING ABSORBANCE NO_2^- Table 7

$c(N\text{-}NO_2^-)$[mg/L]	$c(NO_2^-)$[mg/L]	A_1	A_2	A_3	$A_{average}$
0	0	0	0	0	0
0.030	0.100	0.749	0.789	0.761	0.781
0.046	0.150	1.223	1.081	1.122	1.142
0.061	0.200	1.726	1.473	1.455	1.551
0.076	0.250	1.980	1.905	1.820	1.901
0.122	0.400	2.733	2.873	2.850	2.818
0.137	0.450	2.408	3.011	3.013	2.810
0.152	0.500	3.328	3.342	3.388	3.352
0.183	0.600	3.595	3.621	3.851	3.689

Typical concentration of nitrite is very low, often under the detection limit. Classical Technique 1 is relatively simple and quick. Disadvantage of this method is α-naphtylamine photosensitivity. The HI 83215 instrument does not provide analyses of this parameter.

Ammonium cations (NH_4^+) occurring in groundwater as a product of microbial activity. NH_4^+ ions are an important indicator of fresh contamination. From health point of view, ammoniacal nitrogen is very important, because it is one of the primary products of the organic nitrogen substances decomposition. Therefore, it is a chemical indicator of water contamination by animal wastes. Ratio of ammonium ions and ammonia in water is pH dependent (5). For spectrophotometric determination of ammonium cations by Nessler reagent according to the STN ISO 750-1 (75 7451) standard, a calibration curve relating absorbance to concentration of ammonium nitrogen and a calibration curve of absorbance to ammonium cations concentrations were plotted (Fig. 4). The obtained equations are:

$$N\text{-}NH_4^{+}: \quad A = 0.7195\times c \qquad R^2 = 0.9962$$
$$NH_4^{+}: \quad A = 0.5587\times c \qquad R^2 = 0.9962$$

where *A* is absorbance and *c* is concentration (mg/L). The measured values relating absorbance of NH_4^+ concentration are available in Table 8.

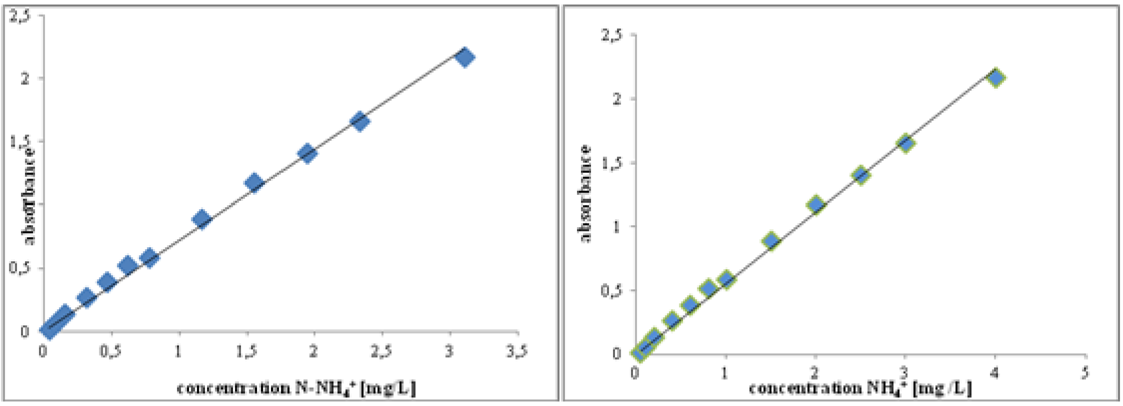

***Fig. 4** The calibration curve relating absorbance to concentration of N-NH_4^+ and NH_4^+*

THE MEASURED VALUES RELATING ABSORBANCE NH_4^+ Table 8

c(N-NH_4^+)[mg/L]	c(NH_4^+)[mg/L]	A_1	A_2	A_3	$A_{average}$
0.039	0.050	0.010	0.013	0.011	0.011
0.078	0.100	0.067	0.044	0.055	0.055
0.155	0.200	0.128	0.128	0.135	0.130
0.311	0.400	0.264	0.265	0.268	0.263
0.466	0.600	0.383	0.383	0.389	0.385
0.621	0.800	0.516	0.515	0.517	0.516
0.776	1.000	0.593	0.598	0.553	0.581
1.165	1.500	0.905	0.886	0.858	0.883
1.553	2.000	1.255	1.101	1.156	1.174
1.941	2.500	1.421	1.396	1.396	1.404
2.329	3.000	1.655	1.646	1.671	1.657
3.106	4.000	2.164	2.172	2.167	2.168

Determination of ammonium cations by both techniques is comparable to demands and the necessary time. Technique 2 allows the determination on the higher concentrations.

Phosphate ions (PO_4^{3}) - the major sources of phosphates in waterways are municipal sewage sludge and fertilizer for crop production on farms. Phosphates themselves are not toxic. Their high content in the river and lake water causes excessive growth of algae. Algae on the surface of the water avoid contact with atmospheric oxygen and substantially interfere with the biological processes in the water. Water contains less dissolved oxygen and becomes unsuitable for the organisms living in it. Eutrophication of water slows down the self-cleaning process, causing the half-life contaminants in waterways extending (5). For spectrophotometric determination of phosphate ion PO_4^{3-} by Molybdenum blue method according to STN EN ISO 6878 (75 7465), a calibration curve relating absorbance to concentration of total phosphorus and a calibration curve of absorbance to phosphates concentrations were plotted (Fig. 5). The obtained equations are:

$$\text{P-PO}_4^{3-}: \quad A = 1.9499 \times c \qquad R^2 = 0.9994$$
$$\text{PO}_4^{3-}: \quad A = 0.6358 \times c \qquad R^2 = 0.9994$$

where A is absorbance and c is concentration (mg/L). The measured values relating absorbance to PO_4^{3-} concentration are available in Table 9.

The biggest advantage of using the Technique 2 is stability of the reagents. During the preparation of mixed reagent (Technique 1), many errors can occur (e.g. not well tempered sulphuric acid can decompose ammonium molybdate, potassium antimonyl tartrate must by freshly prepare...). Moreover, the stability of this reagent is restricted to four hours.

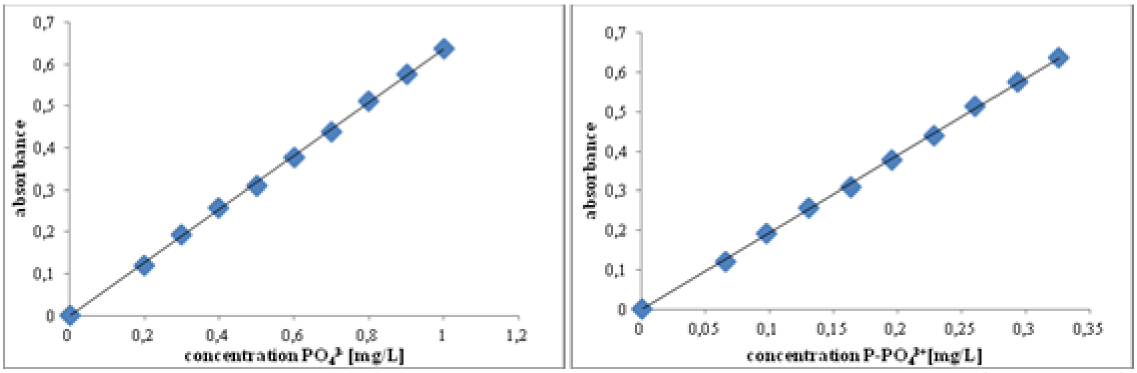

Fig. 5 *The calibration curve relating absorbance to concentration of P-PO_4^{3-} and PO_4^{3-}*

THE MEASURED VALUES RELATING ABSORBANCE P-PO_4^{3-} AND PO_4^{3-} Table 9

c(P-PO_4^{3-})[mg/L]	c(PO_4^{3-})[mg/L]	A_1	A_2	A_3	$A_{average}$
0	0	0	0	0	0
0.0650	0.200	0.130	0.110	0.122	0.121
0.0978	0.300	0.201	0.180	0.197	0.193
0.1304	0.400	2.275	0,245	0.253	0.258
0.1631	0.500	0.307	0.305	0.316	0.309
0.1957	0.600	0.381	0.371	0.379	0.377
0.2283	0.700	0.436	0.439	0.445	0.440
0.2609	0.800	0.520	0.503	0.515	0.513
0.2935	0.900	0.576	0.564	0.591	0.577
0.3261	1.000	0.645	0.626	0.634	0.638

Conclusions

In this paper, we provide the comparison of usability of laboratory spectrophotometer TermoSpectronic™ and the field photometer HANNA HI 83215 for determination of the selected nutrient concentration. In general, the field photometer is better for higher concentration of nutrition (e.g. in surface water and wastewater), while laboratory spectrophotometer is better for lower concentration (e.g. for groundwater).

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INFLUENCE OF THE FLOW RATE OF OXIDISING ATMOSPHERE ON THE FLAME SPREAD RATE ON THE SURFACE OF ORGANIC SETLLED DUST

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Veronika VALENTOVÁ

Abstract

The presented paper deals with determining the influence of the flow rate of oxidising atmosphere on the flame spread along the surface of the organic settled dust layer. We determined the rate of the flame spread on the surface of the organic settled dust layer (whole grain rye and spelt flour) with absolute moisture of 10 % wt., for the flow rates of oxidising atmosphere 1, 3, 5 and 10 cm/s. Pure oxygen was used as an oxidising atmosphere. The obtained results suggest that there exists a power relationship of the flame spread rate along the surface of organic settled dust layer to the flow rate of the oxidising mixture. The method described is suitable for the relative comparison of the organic settled dust layer from the point of its ability to spread the flame and the influence of the air flow rate on this process.

Key words

Dust · Dust layer · Flame spread rate · Oxidising mixture flow rate · Dust fire risk assessment.

Introduction

Dust is defined as all particles less than 0.5 mm in two dimensions (1). In the working area, dust can occur in the form of dispersed dust (aerosol) or settled dust (aerogel).

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Fire hazard of dispersed dust is primarily determined by its ability of explosive combustion in the cases when its concentration in the air is between the lower and the upper explosive limits. The influence of the external conditions as well as of the chemical and physical characteristics of the dispersed dust on its initiation ability is more thoroughly described in (2-4). The most important influence on the sensitivity of a dust cloud to ignition and the resulting explosion has, besides its chemical composition, dust distribution of particle size. The sensitivity of a dust cloud to ignition and the resulting explosion violence (severity) increases with a decrease in particle size (4).

Fire hazard of settled dust depends on its chemical composition, particle size distribution and external conditions (flow rate of oxidising atmosphere, temperature, oxygen concentration in oxidising atmosphere, direction of oxidising atmosphere flow and a number of other factors). Fire hazard of settled dust depends on its ability of flameless combustion. During flameless combustion, a great amount of toxic combustion gases is released. In addition, flameless combustion can take place with no visible signs which would enable its identification without detectors. After a relatively long period, flameless combustion can shift to flame combustion at the most unexpected time. In a manufacturing site with the minimum number of persons present, such a shift can cause great damages owing to the late observation of fire.

Figure 1 illustrates the ratio of chosen dust species involved in dust incidents in the USA.

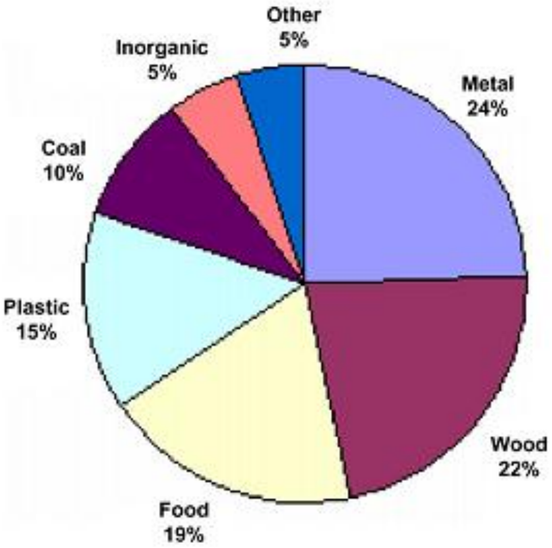


Fig. 1 *Type of material involved in dust incidents (5)*

Figure 2 shows dust incident breakdowns per industry in the USA.

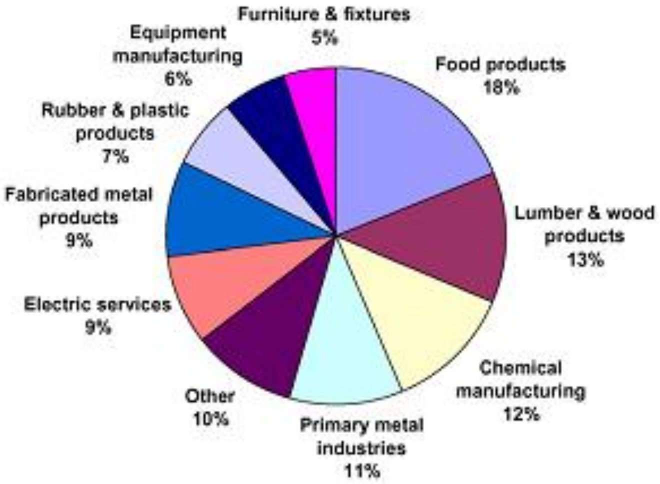


Fig. 2 *Dust incident breakdown per industry (5)*

Similar breakdown of a material type involved in dust incident and dust incident per industry is valid for the European Union or Slovak Republic. The most dangerous are organic dusts processed in the wood and food industry.

Fire risk assessment of dust is practicable by the determination of dusts fire characteristics. Fire characteristics of wood and food dusts have been determined by several authors (6, 7 and 8). For example Slabá and Kasalová-Balog (6, 7) measured the minimum self-ignition temperatures of settled dust of oak (320 °C), beech (320 °C) and spruce wood (320 °C) and also wheat (> 400 °C) and corn flour (> 400 °C). According to (6, 7) the minimum ignition temperature of wheat flour dust cloud is 458 ± 2.7 °C and the minimum ignition temperature of corn flour dust cloud is 460 ± 3.5 °C.

The flame spread rate along the surface of chosen wood and food dusts was measured by Slosiarik (9). The flame spread rate was determined at the oxygen flow rate 0.85 cm/s. Figure 3 illustrates the influence of water content and thickness of dust layer of smooth flour on the flame spread rate along its surface.

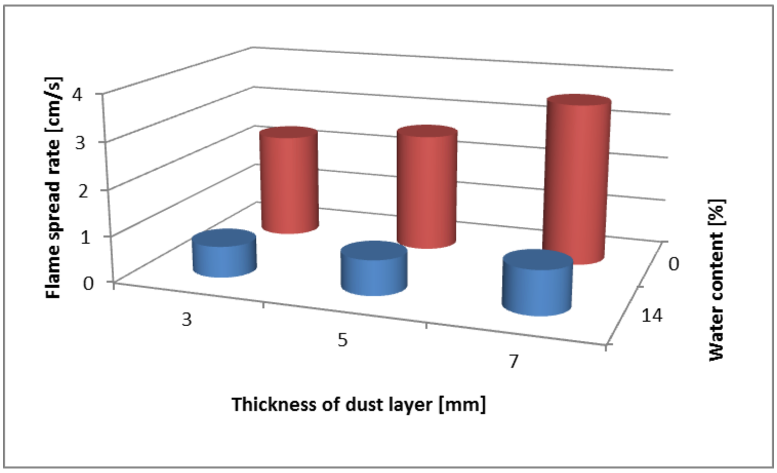


Fig. 3 *Influence of smooth flour layer thickness and its water content on flame spread rate on its surface (9)*

Despite the relatively deep research into dust clouds and settled dust behaviour under fire conditions, there are still missing data about the influence of oxidising atmosphere flow rate on flame spread rate along the surface of settled organic dust. Therefore, the goal of this paper is to measure the influence of the flow rate of oxidising atmosphere (pure oxygen) on the flame spread rate along the surface of the whole grain rye and spelt flour. Another goal is to compare the inflammibility of the investigated materials.

Methods

In the experiment, whole grain rye and spelt flour with absolute moisture of 10 % were used. The particle size distribution of the tested flour is shown in Figure 4.

The influence of the flow rate of oxidising atmosphere was determined using the FTA Flammability apparatus schematically presented in Figure 5. The photo of the used testing apparatus is shown in Figure 6.

Pure oxygen was used as an oxidant. The flame spread rate was determined for four different oxygen flow rates (1, 3, 5 and 10) cm/s. The thickness of dust layer was 5 mm.

The oxidising atmosphere was flowing against the direction of the flame spread. The counter current flame spread was chosen in order to retain the opportunity to compare the measured data with the data in the scientific literature valid for the oxygen flow rate close to 1 cm/s.

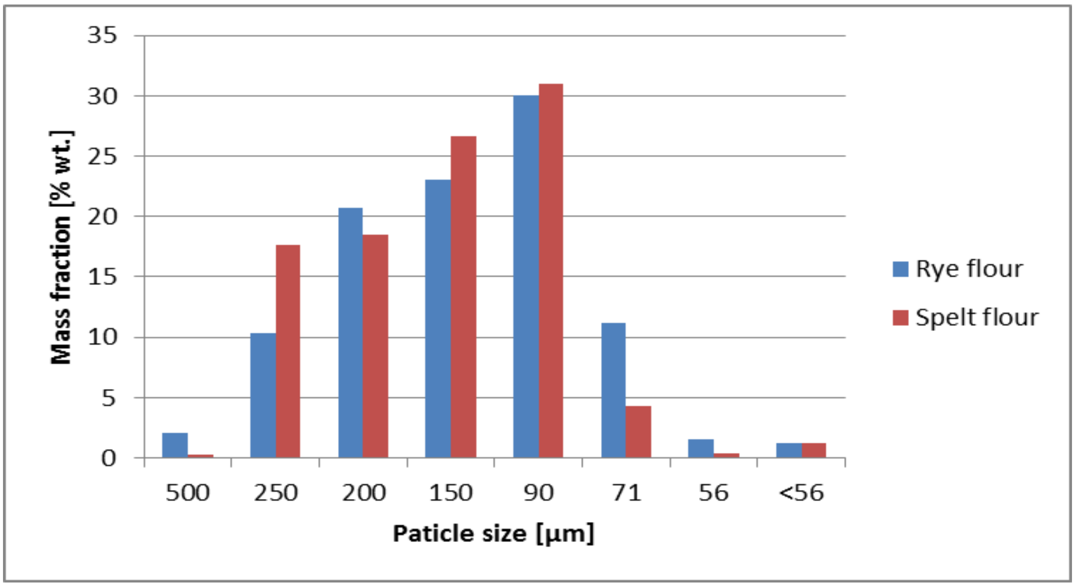
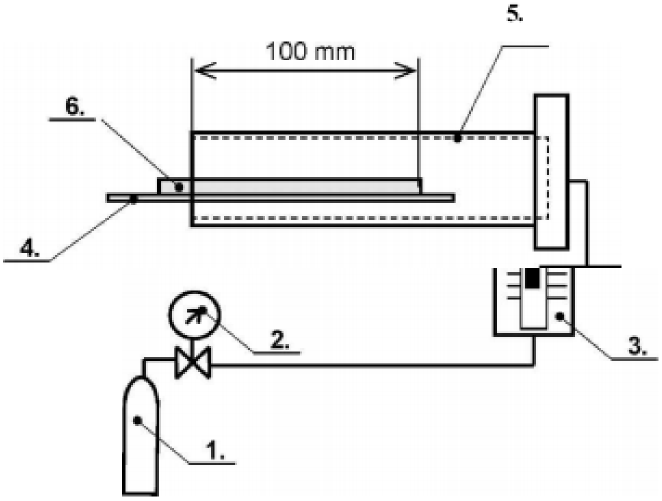


Fig. 4 *Particle size of the tested flours*



1 – oxygen pressure vessel, 2 – reducing valve, 3 – flow meter with a needle valve, 4 – sample holder, 5 – fused-silica tube, 6 – sample

Fig. 5 *Schematic diagram of the FTA Flammability apparatus*

Fig. 6 *Photo of the used FTA Flammability apparatus*

Prior to the measurement, oxygen flow was set to the measured oxygen flow rate using the flow meter with a needle valve (3). The vessel for the sample (4) was filled with the analysed sample in the form of dust. The sample was aligned with the upper edge of the vessel and put into the fused-silica tube (5). The prepared apparatus was left for five minutes to ensure thorough mixture homogenisation. After this period, the sample was lit at the edge of the vessel. When the flame spread up to the first mark (i.e. 20 mm from the sample edge), the stopwatch was started. The stopwatch was stopped when the flame spreading along the surface of the dust layer reached the second mark (at the distance of 100 mm from the first mark). The flame spread rate along the surface of the settled dust was calculated using the known distance between the two marks and the spread time.

Results

The performance of the flame spread rate on the surface of the whole grain rye and the spelt flour is presented in Figures 7 and 8, respectively.

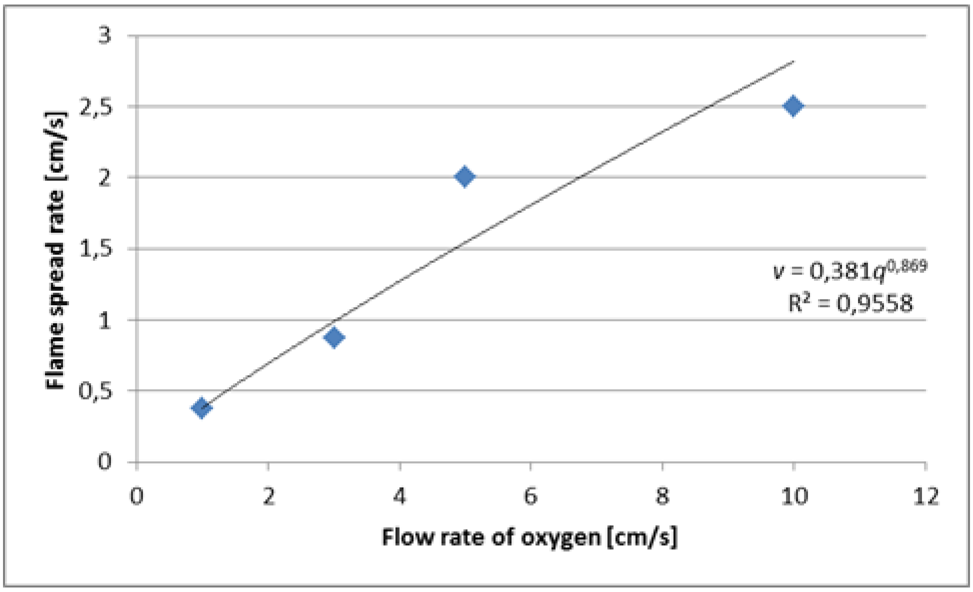


Fig. 7 *Relationship between the flame spread rate on the surface of the whole grain rye flour and the flow rate of oxygen that ranged from 1 to 10 cm/s*

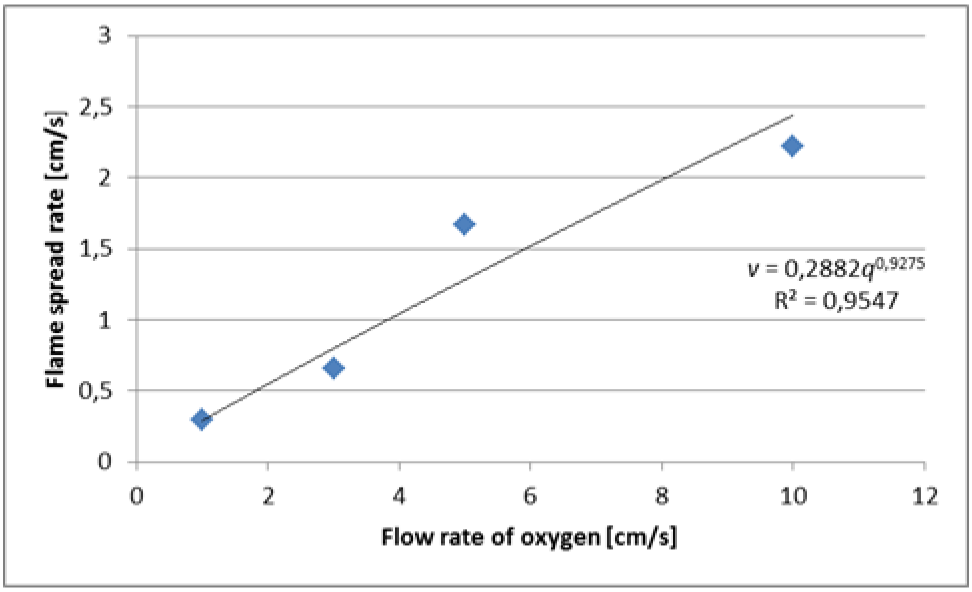


Fig. 8 *Relationship between the flame spread rate on the surface of the spelt flour and the flow rate of oxygen that ranged from 1 to 10 cm/s*

The analysis of the measured data revealed the power relationship between the flame spread rate and the oxygen flow rate. On the basis of the visual observation we presume that, in the range of oxygen flow rate from 1 to 5 cm/s, the relationship between the flame spread rate on the surface of the materials and the oxygen flow rate could be exponential. However, for clear conclusion, it will be necessary to make multiple measurements (for flow rates of oxygen 1, 2, 3, 4 and 5 cm/s). The decrease of growth dynamics of flame spread rate with flow rate of oxygen increase was identified between oxygen flow rate from 5 to 10 cm/s. This effect can be explained by different effect of oxygen flow rate to flame spread rate along the material surface (not only settled dust layer). At the low flow rate in the oxygen atmosphere, each increase of flow rate will cause enhancement of the amount of oxygen on burning. Amount of release rate during burning is proportional to the consumed oxygen. According to Lyon (10), amount of heat release is equal to (13.1 ± 0.7) kJ heat on 1 gram of the oxygen consumed. Therefore, each increase of oxygen flow rate causes increased heat release rate and higher heat release rate subsequently causes the higher flame spread along the surface of material (settled dust). However, the (counter current flame spread) flowing oxygen atmosphere causes heat removal. Heat removal also increases with the oxygen atmosphere flow rate increase. Therefore, the flame spread along the settled dust surface will be increasing with increasing the flow rate of oxygen atmosphere only up to a certain (first) critical value of the flow rate. This (first) critical value is defined as the flow rate at which the flame spread begins to decline. Further increase of flow rate causes further increase of heat removal until equality between heat release by burning and heat removal by flowing of oxygen is achieved. This (second) critical flow rate is accompanied by extinguishing flame. The values similar to those for the oxygen flow rate equal to 1cm/s, were published by e.g. (9, 11-12). For example according to Slosiarik (9), the flame spread rate along the surface of 5 mm thickness layer of smooth flour with 14 % wt. water content at the oxygen atmosphere flow rate 0.85 cm/s was 0.76 cm/s.

Conclusion

The method described above is suitable to compare dusty materials from the point of their ability to spread the flame on the surface of the settled layer. In contrast to the classical oxidation rate test, our method allows to determine the influence of the oxidant´s flow rate on the flame spread rate along the surface of the settled dust.

We demonstrated the strong dependence of flame spread rate on oxidising atmosphere flow rate at counter current flow of oxidising atmosphere.

Further research should focus on determining the influence of particle size distribution on flame spread rate along the settled dust surface and discovering the fraction with the maximum flame spread rate. Furthermore, future research should determine the dependence of the flame spread rate along the settled dust surface on the oxidising flow atmosphere rate at the oxygen atmosphere flowing current flow of flame spread. It should also determine the critical flow rate of oxygen atmosphere at which decrease of flame spread rate along the settled dust surface could be observed, and the critical flow rate of oxygen at which flame spread on settle dust surface extinguishing could be observed.

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THE MARKETING CONCEPT IN AN ACADEMIC ENVIRONMENT

Kvetoslava REŠETOVÁ

Abstract

Universities, as subjects of the academic environment, are institutions with the priority of education and research. The task of the marketing concept in the academic field is to communicate with all important target groups to support a stronger position and their perception of the school. The aim of the intervention is to increase the prestige, improve awareness, support positive attitudes, and present successful results in all areas of activity. This means creation and protection of a ***positive image****, which enables higher interest of all target groups and secures better awareness about it.*

Key words

marketing management, academic environment, presentation maps

Introduction

A study of the marketing strategies of non-profit organisations highlights the characteristics of this responsibility as a task which is not a priority, but it nevertheless plays a very important role. It is a very difficult task to persuade some people that a programme of development and a strategy for any enterprise represents a legitimate marketing problem. One of the processes is, for example, the promotion of products or services with advertising, publishing or special events to show the key benefits uncovered in research and in other ways (Akchin, D. 2001).

The long-term success of a manufacturing enterprise (as well as enterprises providing services) depends on the quality of its management in one distinctive way. Therefore, it is important to search for particular adequate and efficient systems of management and to improve them consistently (Tréning, 1998). In this context, **enterprises providing service** include also “enterprises” providing the highest education – meaning **universities** (and at a lower level - faculties of a university).

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The marketing concept of an education institution

The **marketing management** of an institution in the area of services is defined as analysis, planning, implementation and control of precisely defined programmes designed to process voluntarily an exchange of values with target markets to reach the institution's tasks. Marketing presents the plans the university offers to fulfil the needs and wishes of target markets, apply efficient communication, and to distribute information, motivate and provide services to these markets. The basis of the implementation of the marketing and the strategic marketing philosophy in a particular institution is the ability to create, keep and develop a required connection between institutional aims defined on the basis of its role to process tasks in connection to reserved sources, also in changing conditions.

A **marketing philosophy** is understood as the way an institution exists on the market, as well as a set of activities focused on the implementation of this philosophy. The form of the university marketing concept presents the most modern method of marketing, entrepreneurial thinking and action in a competitive area.

Outputs for implementation of aims of the marketing philosophy in internal structures of the academic field

- A marketing philosophy related to public relations is a file of clearly defined aims, which task is not in coincidental or repeating activities, but in a systematically planned, managed and organized process.
- A university with marketing management makes a selection of target markets; this means it does not offer everything for all, but it distinguishes market segments in a very professional way and it selects differentiation often completely differently attributed to them.
- Public relations help to profit on the basis of efficient satisfaction of needs by target markets, which requires a clear declaration of the university's aims.
- A marketing philosophy where public relations support processes of decision making.
- Aim of marketing philosophy of the university is the definition of the utility properties which are sufficiently attractive for the target market.
- The marketing philosophy of the university uses a set of marketing tools defined on the basis of the academic filter and analytical processes.

Marketing environment of university

To understand correctly the above-mentioned outputs, it is necessary to define the **marketing environment** of a particular university. An education and research university has to go from knowledge of the marketing environment where it wants to be implemented or where it is already situated by the study of future risks. This environment is formed by all factors and influences which determine the ability of efficient exchange with the target market.

The result and reason of defining and monitoring the marketing environment of an education institution is the processing of a **marketing situation analysis,** or marketing audit.

It is a critical, objective, systematic and detailed study of the internal situation at the university with a focus on the marketing activities and study of its position in a specific environment with market analysis. Situation analysis is a method which can help to define a university's position as a unit but also in comparison with similar education institutions at home and abroad on the basis of an analytical evaluation of past development and the contemporary state on the basis of qualified estimation of future development in a strategic time. Besides this, there will be tools used for strategic planning and strategic management, analysis of customers and customer strategies, and analysis of competitors (competition analysis) in the implementation of the marketing concept of the university.

The content of the marketing concept of a university

The content of the marketing concept of a university is:

- professional compensation of all important relations and processes at university,
- active presentation, implementation and harmonization of all important interests,
- creation of a positive image of university.

Quality and efficient communication with the internal audience of the university, consistent maintenance of mutual real information flow belong to the basic presumptions of the creation of feeling from mutual understanding, fellowship and pride in one's own institution.

A marketing concept should be a **function of the top-management of a university** from the perspective of its main principles. It helps the flow and maintenance of mutual information exchange; it strengthens a positive perception and cooperation between the subject and its recipients, including communication of management with employees. Completion of the marketing concept must be in the centre of the communication field of the organisation, it should reflect all crucial information, events and facts regarding the activity in and around the university.

Opportunities for completing the marketing concept:

- repeating opportunities:
    - ceremonial opening of the academic year
    - graduation ceremonies of graduates
    - meetings of academic employees
    - university anniversaries
    - publication of journals
    - participation in trade fairs and exhibitions
    - day of open house
    - reports on activities of university
    - support of cultural activities of students
    - support and sponsorship of sport activities
- irregularly occurring and random opportunities for marketing:
    - implementing new study programmes at the university
    - presenting achieved success in research – new inventions, patents, awarding special recognitions
    - opening new areas, top technical equipment, initializing new technological processes
    - issuing a significant publication

  - awarding a famous person
  - visiting foreign institutions

- intentionally designed events for marketing:
  - initiatives and actions for the benefit of the public, health, protection of environment
  - grants as a part of the school (for example to support foreign study programmes of students)
  - participation of the university in important solutions and projects for society
  - work with graduates (the creation of an alumni society,...)

Aims and tools of marketing in the academic environment

The aims of marketing in an academic environment definitely include: to inform about the faculty, to present its unique position and elements which show its uniqueness in comparison to others, to improve relations inside the institution, and to inform about the behaviour of the environment.

Specific tools of university marketing can be partially characterized as:

- media news, press information,
- author contributions, publishing,
- media events,
- meetings with partners and potential partners,
- building of multimedia workplaces with the aim to gain and realize:
- information from information systems and networks
- brilliant presentations of qualification processes
- presentation of results of pedagogical and research activity with the aim to gain :
  - ☐ presentation of guaranteed quality with an absolute service
  - ☐ transfer and performance of an exact projection
  - ☐ possibility of selection and flexibility by projection
  - ☐ optimal support for presentation
  - ☐ clarity and reliability
- creation of web pages and multimedia promotion and information materials.

Target groups of marketing and presentation aims of the faculty can be divided into:

- domestic – external: general public, professional public, graduates, potential students, potential teachers, sponsors, state and autonomous organs, state enterprises and entrepreneurial subjects, the third sector, community in the closest environment of school and community of other universities, media and journalists;
- domestic – internal: students, employees of the faculty;
- foreign: partners, potential students, trainees, professional organisations, foreign universities and professional communities.

If a faculty has a clearly defined aim, content and tools of the activity of its PR, then it is able to create **presentation maps** (a presentation map is a tool for mapping the environment of influence), creating an interactive connection of the activity at the faculty with the presentation environment, and emphasizing the unique aspect of its activity.

A presentation map can cover various activities of public relations of the faculty, as we can see from the experience of the Faculty of Materials Science and Technology:

PRESENTATION MAP IN ACADEMIC ENVIRONMENT						
Promotion of study		**Media space**		**Monitoring**		**Publications about subject**
• participation in trade fairs and exhibitions • open house • promotion video about study programmes • days of education advisory • summer universities for students of secondary schools • leaflets and advertisement about education at faculty • publications about graduates profile		• DVD about faculty • virtual visits • video presentations • Facebook • discussions in media • regional print • administration of webpage of the faculty		• monitoring of academic events • monthly overviews about events at the faculty • presentation about events in university journal • daily news • surveys • FAQ		• Annual Report • presentation publication about the faculty • anniversaries • leaflets about the faculty • publications about research • publications about faculty workplaces • publications about centres of excellence
Trade Fairs and Exhibitions		**Conferences**		**Cooperation with practice**		**Visits**
• participation in professional research exhibitions and trade fairs • workshops • exhibitions of centres of excellence		• organising domestic conferences • participation in foreign conferences • conference service		• presentation of companies at the faculty • presentation of the faculty in companies • offer of cooperation with practice • discussions with representatives of practice • monitoring technological processes from practice into teaching at the faculty		• welcoming guests to the faculty • the faculty visited by foreign partners • memoranda about cooperation

Alumni		**Expositions**		**Awards**		**Service Public relations**
• portal of graduates • bank of successful graduates • job opportunities for graduates • benefits from membership in community of graduates • newsletter		• permanent expositions of vision of faculty development • expositions of posters • technological museum		• award of the faculty • awards of faculty employees • awards of students of the faculty		• communication tools • uniform design of the faculty • promotional subjects, multimedia equipment • multimedia service
Social events		**Galleries**		**Public**		**Sport actions**
• new year meeting • meetings with former employees • meetings with children of the faculty employees • balls • theatre performances • concerts		• gallery of deans • gallery of professors • gallery of personalities of science and technology • gallery: Doctor honoris causa • gallery of professor emeritus		• information for public • organizing events and exhibitions for public • supporting public events • building		• tennis tournaments • sport days for employees

Conclusion

Implementation of the marketing concept into the management of an academic institution requires changes connected with the need of modification of the existing processes and also a complex modification of the culture and strategy of the faculty.

Characteristics of possible **contributions** to the marketing concept define:

- **on the level of university management (top-management)**
  - A complex maintenance of data files containing the important activities of university
  - Update and modification of information to perform management activities (preparation of decisions) of university representatives
  - Update and modification of information for communication with university management
  - Integration and rationalization of creating and processing the information for intention concepts of university (strategic planning);

- **on the level of management of professional activities via university workplaces**
  - Securing professionalism, complexity and continuity of collection, processing, distribution, protection and archiving of information file of activity results of university marketing concept,
  - Integration of professional activities, increasing the range, content, quality and speed of provided services,
  - Exclusion of duplications in professional activities and formation of presumptions for their processing (organization, technical, personnel),
  - operative control of content correctness of provided information,
  - removal of the campaign aspect,
  - creation of space for a cooperation offer with industrial practice and university partners.

Measurement of efficiency by securing marketing philosophy implementation and strengthening of public relations as a part of organisational university structure is not a simple issue. However, the financial cost of the operation can be quite exactly estimated, the resulting effects are difficult to measure. While for example marketing information system is measurable with an increased finance profit from sale, these effects of influence and formation of “non-productive-costs” of the university are shown only in an indirect and not immediate way. A university education institution cannot operate with a proportion of cost and profits as one of the main criteria, but on other side, the question of efficiency should not be forgotten (Kimlička, Š. 1995).

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