METHODS OF MONITORING OF AIRPORT AND AIRCRAFT DE-ICING MATERIALS

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The aim of this article is to describe the different types of icing that affect the aviation safety. The article deals with the de-icing materials which are used to de-ice aircraft and airport movement areas. Because all of this de-icing materials may pose a threat to the environment after application, monitoring of their constituents in the waste water is gradually introduced at all airports. The implementation of monitoring of de-icing materials at the airports lies primarily in determining the required parameters, which are necessary to monitor. Once the desired parameters is selected, they must choose the types of monitoring systems and choose the methods by which the various parameters of de-icing materials are monitored. In order to implement monitoring at the airports, it is necessary to know the whole process of implementation of monitoring systems.

K e y w o r d s: Icing, de-icing materials, on-site monitoring, off-site monitoring, handheld monitors, test kits, online monitors.

1 INTRODUCTION

During winter each airport must use a large amount of de-icing materials whether to defrost aircrafts or airport movement areas. During aircraft defrosting, these materials are collected either by traps, from which are then siphoned off by cisterns, or by piping connected to the wastewater storage tanks. Airports may further process the applied de-icing materials or discharge them to surface waters. In this case they have to use the mentioned wastewater storage tanks, in which will be the wastewater threaten and subsequently is performed the monitoring of de-icing materials.

During airport movement areas defrosting is the process more difficult because the de-icing materials flow into the drainage system along with the water that comes out of ice or snow and flow into the surface water. Although the de-icing materials are pretty much harmless to the environment, on the basis of research has emerged that this materials can threaten aquatic life in surface waters. Therefore, especially at U.S. airports was introduce monitoring, which examines the quality of wastewater. This monitoring is introduced mainly at airports, which are located near large rivers and oceans. The basis of this monitoring is to ensure foolproof protection of the environment.

Before implementation of the monitoring is needed to consider several factors. First is needed to focus that what type of de-icing materials are used at the airport to defrost aicraft and airport movement areas and on this basis to determine, what parameters will be closely monitored. After selecting the appropriate parameter will be determined which instruments and methods of monitoring will be chosen to monitor this parameters at airports.

Lastly, it is necessary to focus how airports can implement monitoring systems. Implementation of monitoring systems may be performed at each airport otherwise.

2 THE IMPACT OF THE ICING ON THE AVIATION SAFETY

One of the most dangerous weather event in aviation is the icing. It is formed on all types of aircraft and helicopters. Icing on aircraft aggravates their flight and aerodynamic performances, which can sometimes cause a crash. Flight and aerodynamic characteristics of aircraft due with the icing are changed with the intensity of icing, the total amount of ice, its structure and geometric shape. Icing conditions are divided into 2 groups:

- Aerodynamic - surface temperature of aircraft, aircraft speed, size rising of aircraft surfaces, curved rising of aircraft surfaces,
- weather - humidity of the air mass, temperature of the air mass, cold water drops, particle size distribution.

Icing significantly deteriorate aerodynamic and flight characteristics of the aircraft, especially on the wings and tail surfaces of the aircraft. Icing changes the shape of wrap parts, increasing frontal resistance and reduces the lift, increasing weight, increasing the needed and reduces the excess engine thrust. All this causes a reduction of the vertical rate of climb, reducing maximum speed of flight, leads to increased fuel consumption and affects the characteristics of the landing of aircraft.

Types of icing are varied and depend on many factors. Particularly the most important is the size of droplet, temperature, flight mode and the occurrence of ice crystals in clouds. The basic types of icing are clear ice, rime and grained ice. In terms of shape, in which the icing is produced primarily on the leading edge of wings, are also important profile frost, grooved frost and mushroom frost. In terms of the type of icing is the most dangerous clear ice, in terms of shape grooved or mushroom frost.

3 DE-ICING MATERIALS USED ON THE AIRPORTS

De-icing materials at airports are an integral part of winter maintenance. To defrost the aircraft at the airport of Košice a.s is used liquid of type I and II. These liquids are Safewing MP I 1938 ECO and Safewing MP II FLIGHT. The airport buys these liquids from company Clariant International Ltd. from the warehouse in Germany, from where they are imported by cisterns.

Their fluids are labeled ECO what means, that they are highly careful to the environment. Shortly after delivery is controlled refractive index, pH values and at the same time carry out a visual inspection of the liquids. When is delivered the liquid type II, so it is a liquid Safewing MP II FLIGHT, is needed also the monitoring of the viscosity, which is carried out by three tubes, which are shown in picture n. 1.

Figure 1 Safewing MP II FLIGHT - viscosity test

To defrost the movement areas in airport of Kosice is used urea, which is considered to be relatively inexpensive and harmless liquid. Addition of urea may be used de-icing materials based on glycols, acetates, phosphates, and ammonium compounds.

4 REQUIRED PARAMETERS OF MONITORING

All these de-icing materials are concentrated so as to be the most careful to the environment. However at the airports is introduced the monitoring of wastewater which contains ingredients of de-icing materials, by which is determined if these components of waste water are so contaminated that they could cause environmental pollution. The parameters of de-icing materials which will be monitored in the wastewater depend on airport conditions, types of deicing fluids and requirements for defrosting process. The most common parameters are directly related to primary deicer constituents and include glycols, surrogates for primary deicer constituents and ammonia. Other parameters that can be monitored at airports when using de-icing fluids are acidity and alkalinity pH, the amount of oxygen in the water and total suspended solids.

The basic primary ingredient of de-icing materials is glycol. Its monitoring in wastewater is almost impossible. Therefore, instead of glycols are measured surrogate parameters, including biochemical and chemical oxygen demand and total organic carbon. For monitoring of biochemical oxygen demand is used BOD5 analysis, which means that the monitoring is carried out within five days. Five days to obtain a result for airports mean a big problem, because it is necessary to know the results as soon as possible. Therefore, for this problem the airports mostly measure the parameters like chemical oxygen demand and total organic carbon by which we have the monitoring results much earlier.

If is used the urea at airports, it is necessary to monitor the concentration of ammonia - nitrogen. It is the concentration of nitrogen contained in the compound of ammonia in the sample of wastewater.

In addition to de-icing components must be monitored the degree of acidity and alkalinity pH, total suspended matter and oxygen in the wastewater.

5 PROPOSAL OF USEFUL TYPES OF MONITORING

To monitor the parameters, which have been mentioned in the article can be used on-site or off-site monitoring type. On-site monitoring refers to those types of monitoring, where the samples are collected and analyzed at the same place. Off-site monitoring is one of the traditional type of monitoring, where samples are collected at the sampling site and subsequently shipped to another location, where they are subjected by laboratory analysis.

What type of monitoring is chosen depends on:

- the number of samples that must be collected to meet the objectives of data,
- timeout, in which the results of the samples must be known,
- the frequency at which the data points are required,
- the required quality data.

The airports prefers the use of on-site monitoring. This method of monitoring distinguishes three types of monitoring systems - handheld monitors, test kits and online monitors. Most preferred version are online monitors, because they may be used to monitor all parameters of deicing components, as well as monitoring the pH and suspended solids. Portable monitors are mostly used only for monitoring the pH and the amount of oxygen in the water. The test kits are used to monitor a wide range of parameters, but not to the extent that online monitors. The following picture shows the different types of monitors.

Figure. 2 Different types od monitor systems

6 MONITORING METHODS OF INDIVIDUAL PARAMETERS

With which method will run the monitoring up depends both on the selected parameter and also the monitoring system (Pic. 3). Based on the picture we can see for which parameters can be used which monitoring systems and also can see with which method will the monitoring systems monitor these parameters.

Monitor type	Parameter				
	BOD	COD	TOC	NH_3-N	pH
Online monitor	Biological oxidation	Photochemical oxidation	Thermal catalytic combustion	Colorimetric	Glass electrode
		Electrochemical oxidation	UV / persulfate oxidation	Ultraviolet / absorbance	Glass free electrode
			UV / ozone oxidation	Ammonia selective electrode	
Handheld	N / A	N / A	N / A	Ammonia selective electrode	Glass or glass free electrode
Test kits	N / A	Photochemical oxidation	N / A	Colorimetric	Test strips
		Colorimetric			Colorimetric

Figure 3 Analytical methods by parameter and type of monitoring

5 IMPLEMENTATION OF MONITORING SYSTEMS

The monitoring system can be performed only after the selection of the monitoring method, manufacturer and instrument of the model. The monitoring system includes monitoring tools, equipment and protocols necessary to support its functions. Characteristic aspects of the implementation phase, which are related to the different types of monitoring systems are shown in picture n..4.

Implementation phase	Activity	Monitoring type		
		Handheld monitor	Test kits	Online monitor
Design and installation	Sampling locations	X	X	X
	Site preparation	(1)	(1)	X
	Sample preparation	X	X	X
	Utility supply			X
	Communication			X
	Shelters			X
Setup, operation and maintenance	Calibration	X	X	X
	Maintenance			X
	Monitor visits			X

Figure 4 Implementation activities by monitoring type.

From the picture is already clear that the first step of the implementation is the election of monitoring system (type of monitoring). Each of these monitoring systems requires determining the location of sampling, sample preparation and calibration for the required parameters. Most demanding of monitoring systems, as implementation is concerned, is the online monitor, which in addition to these activities requires resources and power (electricity or water supply), reporting the results (online monitor works alone unattended, so it's necessary), maintenance (to ensure proper function of monitor) and monitor survey. How the different types of monitoring systems will be implemented at airports, depends on the specific circumstances of airports.

5 CONCLUSION

During the winter period creates frost on the aircraft and airport movement area, which can have a negative impact on air traffic. For defrosting are used different types of de-icing materials. De-icing materials used at airports are easily and rapidly biodegradable. However, just in the process of decomposition in water are consuming large amounts of oxygen, which in turn can threaten aquatic life in surface waters into which wastewater from airports goes.

To avoid degradation of aquatic life in surface waters has been phased in airports monitoring of wastewater containing ingredients of de-icing materials. Implementation of monitoring systems, which performs monitoring wastewater is very difficult and costly affair. They must acquire equipment that would monitor the effluent. It also has to be adapted airport drainage system to be sampled. Lastly, it is necessary constant calibration and maintenance of equipments to ensure reliable monitoring them.

Based on the results of monitoring de-icing materials airports can take measures to reduce environmental pollution.

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