Experimental Module for Removal of Radioactive Slurry From Lrw Storage Tanks

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ABSTRACT

This report gives information on elaboration and creation of an experimental module for removal radioactive slurry from LRW storage tanks. The main functional features of this experimental module are to suspend radioactive slurry packed in the bottom of a storage tank subjected to cleaning-up, to suck the suspended radioactive slurry, to concentrate and separate radioactive slurry in a settling apparatus. The resulting flows from the module are concentrated and preconditioned radioactive slurry and LRW freed from solids. The concentrated and preconditioned radioactive slurry can be further directed for solidification by appropriate methods and LRW freed from solids can be cleaned by commonly used purification methods. The experimental module is supplied with a video-controlling system, which allows supervising the process of slurry removal.

The experimental module is currently under testing with non-radioactive slurry therefore, there are no results of its application for real radioactive waste.

BACKGROUND

In practice, there is fairly often need to release diverse reservoirs from any kind of bottom sediment - sludge or silt – for restoring useful volume of the reservoirs and hence, avoiding possible complication in further processing of liquids being stored in the reservoirs. Application of mechanical means for the purpose is not always possible and reasonable because the reservoir outlets as a rule have limited sizes and moreover the sediment volume can be small. If it concerns liquid radioactive wastes the gravity of problem can be caused by considerable radioactivity of the sediment.

The current state of liquid radioactive waste processing at diverse waste processing firms shows that it is necessary to pay more attention to a problem of efficient and safe handling with radioactive slurry. The problem of radioactive slurry has many aspects every of which is caused by the origin of slurry.

At enterprises such as the Moscow SIA "Radon" which deals only with institutional wastes this problem mainly arises while the interim storage of LRW in special tanks, being used for the purpose. These tanks have a standard volume which varies from 100 m^3 to 1500 m^3. The formation of sediment in the tanks is resulting from various reasons but mainly because of chemical composition of LRW coming to the tanks for the interim storage and further processing. Depending on chemical composition of LRW, presence of hydrocoles in LRW, design features of the tanks, hydrodynamics of flows in the tanks and other various factors the amount, composition and distribution of sediment on the tank bottom can differ.

Recent inventory has estimated the amount of sediment in the Moscow SIA "Radon" storage tanks for LRW can make up to 20 % of total volume of the tanks. At first sight the situation could seem more or less stable because the applied at the Moscow SIA "Radon" technology for the LRW processing has been duly designed but in increasing frequency the experts of the Moscow SIA "Radon" have to face the challenge of different kinds of sediment removal while processing LRW of various Customers. Therefore, it has become a starting point to develop a technology and to design an experimental installation or module for removal of the radioactive sediment (slurry) from the LRW storage tanks of the Moscow SIA "Radon". It is supposed to use the module for outside firms.

In our previous paper for WM'06 Conference there was given some information on different experimental approaches to solve the sediment problem.

CONCEPTUAL

Developing a technology for treatment of liquid waste containing considerable quantities of insoluble substances requires elaboration of a certain concept. Since that time when we for the first time had proposed our concept almost nothing changed in it. Figure 1 represents a functional chart of the concept.

The functional chart should be put in the basis of the treatment of liquid waste containing sediment of any origin.

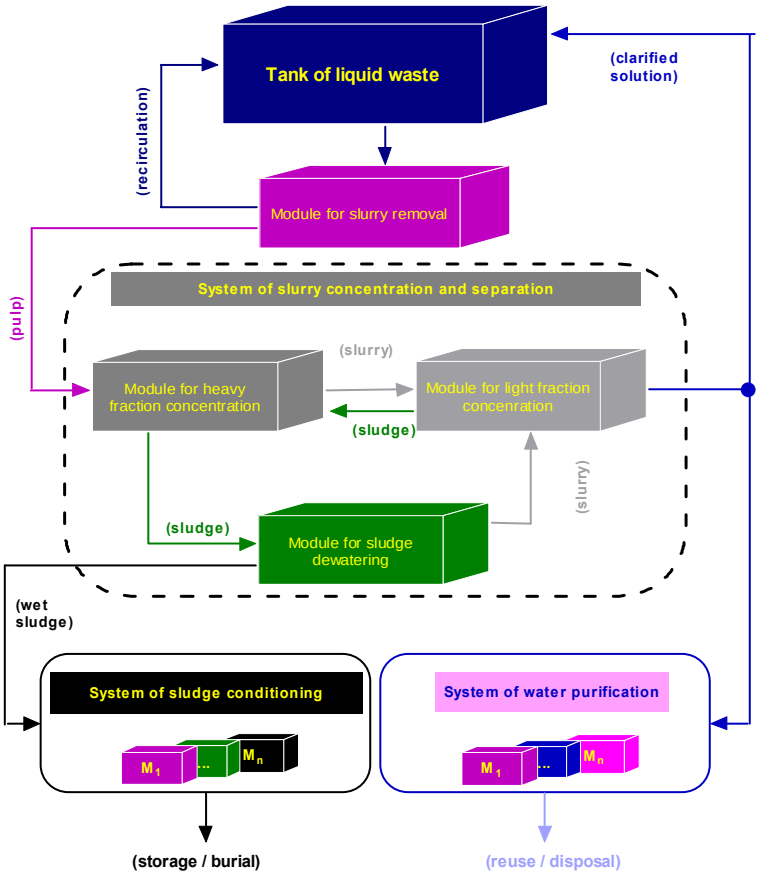


Fig.1. Sludge-containing liquid waste treatment M_1 – M_n – modules or installations

The functional chart includes several systems consisting of modules. Each separate module is a completely self-contained installation, which the functionality is based on one or few methods. Such installation includes the following: one or few main apparatus; auxiliary apparatus providing the regular performance of main apparatus; diverse equipment; a common tray; a support frame for fixing the equipment and for loading-unloading and transportation of the module. Each system consists of one or few modules intended for a certain purpose in the system. In the whole, such way of LW treatment allows flexibly approaching to solving the sediment problem in particular cases.

THEORETICAL

The technology "ECO" for purification of low level liquid radioactive waste has been developed and successfully used by Moscow SIA "Radon" since 1990. According to the given above conception and on the base of the existing technology, a new complex technology "ECO" for LRW treatment is being developed. The flow diagram of the technology is shown in Figure 2.

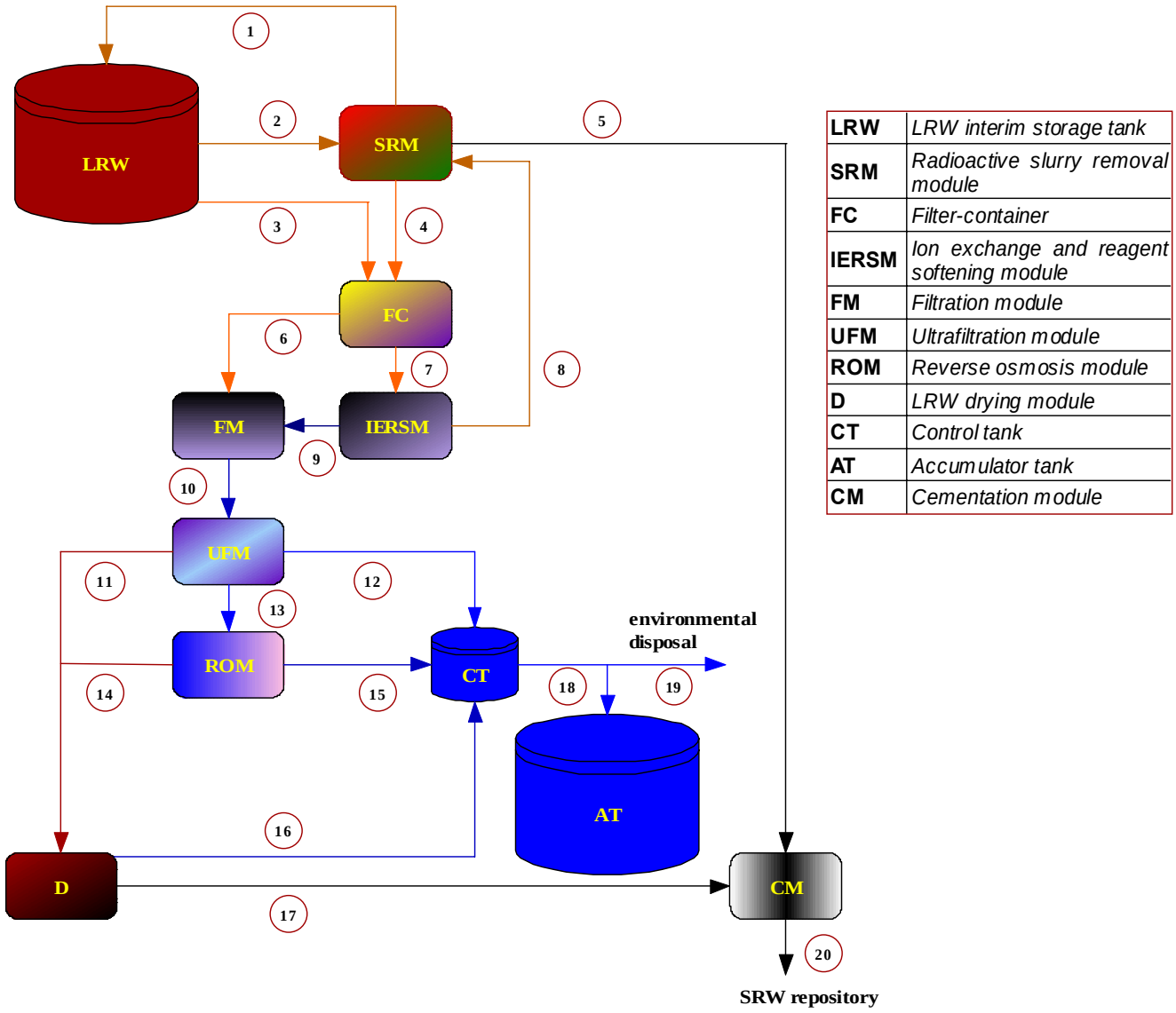


Fig.2. Flow diagram of complex technology "ECO" for LRW treatment

The complex technology "ECO" should apply several mobile type modules mainly intended for the LRW purification.

The Figure 2 gives only one of various variants of the technology application as it supposes the use of required combination of the modules in every individual case or campaign on the LRW purification. It means that the complex technology "ECO" has enough flexibility to be freely composed. In this sense the radioactive slurry removal module is not only an advisable but, to our point of view, obligatory component in the complex technology "ECO" to avoid undesirable complication with sediment in the most purifying modules.

Thus, the complex technology "ECO" is arranged as if of separate "bricks". One plays these "bricks" to combine a variant of technology and satisfy requirements of a Customer.

As it has been said above, the most part of the complex technology "ECO" was developed, made and used in different objects for LRW purification. Currently, this part needs only improving and reconstruction. Nevertheless, such modules as radioactive slurry removal module, ion exchange and reagent softening module, LRW drying module and cementation module have never been used in the

technology "ECO". They are being created or tested now. As far as the paper concerns only the problem of sediment, the radioactive slurry removal module (experimental module) is to be discussed. The experimental module will not be considered in all aspects as it is only a research work and furthermore the developed and created experimental module for removal of radioactive slurry is still under testing and improving.

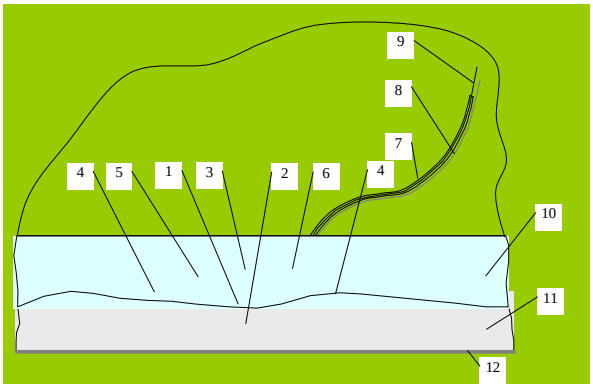
PRACTICAL

The essence of the technology for the radioactive sediment removal consists in scouring the sediment with a water or water-sand jet fed from a high pressure system similar to a hydraulic monitor. The suspended in such way slurry is sucked by a slurry pump (water-jet pump) for the following treatment:

- Separation of a heavy fraction of slurry (up to 80%);
- Concentration of fine particles of slurry and separation up to 50% of chemically unbound water;
- Collection and discharge of heavy and fine fraction of slurry into standard containers or drums;
- Pre-treatment of concentrated slurry before solidification.

For the sediment scouring and suspending, it is reasonable to use LRW stored in the tanks being subjected to cleaning from the sediment. LRW clarified from sediment is returned to the same tanks. Thus, it minimizes possible secondary radioactive waste. On finishing the discharge of sediment from the LRW storage tanks, the latter can be purified from radionuclides by the well-worked-out at Moscow SIA "Radon" membrane-sorption technology. In case of hard-packed sediment havening the morphology similar to a saline cake, it is necessary to foreseen possibility of vibration treatment methods application.

As a variant of radioactive slurry removal module, an apparatus shown in Fig.3 was developed.



1 – submersible pump
2 – base
3 – filter
4 – washout head (jet propeller)
5 – floatage control
6 – shut-off-and-regulating device
7 – hoses
8 – cable
9 – steel rope
10 – LRW
11 – sediment
12 – tank

Fig. 3 Scheme of module for sediment scouring, suspending and removing

The main specification of radioactive slurry removal module developed at Moscow SIA "Radon" is given below in Table.

Table I SRM specification

No.	Parameter name	Value	Note
1	Weight of equipped motor vehicle chassis, kg, not more than	20	
2	Gross weight, kg, not more than	300	
3	Overall dimensions of equipped motor vehicle chassis, mm, not more than: - width - length - height	 330 570 350	
4	Minimum diameter of tank hole for motor vehicle chassis pass through, mm, not less than	450	
5	Motor vehicle chassis action scope, m	25	
6	Speed, m/s: - by land - by water - by bottom under water	 1.0 0.5 0.3	
7	Immersion depth, m, not more than	10	
8	Mover type: - by land (or by bottom under water) - by water		 Caterpillar Screw propeller
9	Maximum drivimg force (calculated), kg	80	Moving by land
10	Motor driver type		Pneumatic
11	Motor pneumatic actuator power, kW	0.36	
12	Capacity of air-compressor, L/min / electric drive power, kW	850/5.5	
13	Slurry pump type		Water ejector
14	Feeding pump parameters: - max pressure, bar - max capacity, L/min - electric drive power, kW	 300 1200 11	
15	Capacity by pumped suspension (density not more 1.15×10^3 kg/m^3), m^3/h, not less than	2	
16	Height of suspension lift (density not more 1.15×10^3 kg/m^3 and capacity not more 2 m^3/h), m, not less than	9	

As it can be understood, the radioactive slurry removal module is the first step of the sediment removal from tanks. Currently, hydraulic trials of the whole experimental module and its separate parts are being carried on with non-radioactive simulator of the sediment from the LRW storage tanks of the Moscow SIA "Radon".

The second step of the sediment removal process supposes application of commonly used methods. There are a lot of variants of the radioactive slurry concentration beginning from such method as a traditional filtration and finally centrifugation. Beginning from 1995 till now experts of the Moscow SIA "Radon" have tested several variants. The main finding is quite obvious; there is no unique method but only a combination of different methods can help the issues of sediment concentration. Figure 4 represents a combined scheme of precipitation-microfiltration process.

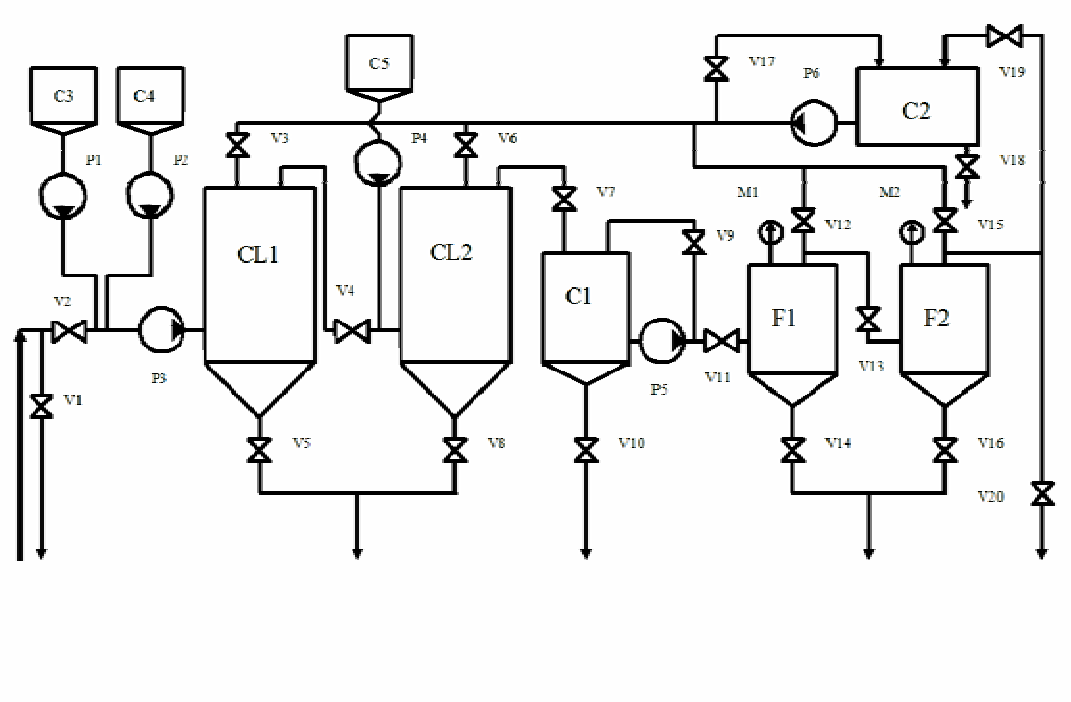


Fig.4. Scheme of precipitation-microfiltration concentration and separation of sediment from LRW suspensions:

CL1, CL2 – clarifiers; P1 … P6 – pumps; C1-C5— capacities; V1 … V2 – valves; F1 - 40 μm filter; M1, M2 – manometers; F2 - 5 μm filter

It is a two-stage precipitation and two-stage microfiltration. Such choice is caused firstly by financial reasons. Nevertheless, we are sure that more effective and less hazardous is a combination of centrifugal and filtering methods. Now the scheme of precipitation-microfiltration concentration is subjected to trials.

CONCLUSION

Investigation and study of possible ways to separate liquid and solid phase are still continued.

Within 2007 it is supposed to receive data for projecting an experimental-industrial module for the radioactive sediment removal from different objects.