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Common strategy to prevent the Danube's pollution technological risks with oil and oil products - CLEANDANUBE

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STUDY 5

STEP 1

Execution details of the new purification solutions of the water infested with oil products

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Study no.5

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This stage has a special importance due to the fact that it is the only one that allows us certain and undoubtedly appreciation of the complexity of equipment providing a new solution for environment protection and underlying the strategy promoted by the project. We can appreciate the scientific newness, as well as very important; we can analyze and assess the economic magnitude of expenditures necessary for the application of new strategies.

This stage consists in the materialization of all anterior practical activities in a complete set of documentation that will emphasize (and will have to resolve) all issues linked to the practical implementation of the proposed solutions. This activity is important not only due to the previous statements, but mostly due to allowing a very accurate assessment of the costs of such solutions which will enable a correct assessment of the economic strategy that will complete the project

COMOTI Bucharest has a large experience in design and realization of such equipments, but having into consideration also other mixtures (with other components rapport relation but still one of the components being oil).

The scientific required level in designing a technological solution like this is very high (and therefore, in this phase, participated specialist researchers) but the advantages and benefits are high and incontestable.

For solving the problem are necessary depth knowledge and practical experience in fields such as chemistry, physical chemistry, materials science, metallurgy physics, surface coatings, fluid mechanics, fluid flow in rotating machines, resistance, etc. but especially the joint work of two project teams.

5.1 Introduction

In this study aims to define standard and auxiliary elements that goes into water infested with petroleum products treatment plants and the development documentation of detailed execution.

Auxiliary devices that goes into the system are according Study no.3, fig.5 following:

-Protective-barrier systems (dams);

-Infested water collection system;

-Filtration and pumping system;

-The storage system of processed products.

5.2 Protective-barrier systems.

The use of anti-oil aims enclosure / insulation of a polluted areas for:

- Preventing uncontrolled spread and displacement of hydrocarbons on the surface:
- Maintaining a strictly delimited area of oil film:
- Promote oil recovery operations (reducing the spreading surface and increasing of film thickness);
- Directing the film to the recovery equipment:
- Protection of vulnerable areas, sensitive.

There are a variety of dams made so far, both in construction point of view and in terms of working conditions and possibilities of use.

In order to select the most suitable type of dam, both in the acquisition phase as and the use is necessary, as needed, all variants of constructive knowledge under the existing classifications.

Multifunctional structure of each type is evidenced by the classification criteria, in close connection with the method which belongs to:

Arrangement to the water surface (area of operation)

- Surface dams;
- Bottom dams

The surface dams acts on floating on water hydrocarbon and the bottom dams acts on hydrocarbons arising from an underwater source (broken pipe, the ship sank, rash below the water).

After working conditions, dams can be:

- For flowing water (rivers, streams, canals):
- For calm waters (lakes, sheltered bays, basins and aquatic port);

- For open sea (offshore).

The differences consist in constructive form, tensile characteristics and mode of anchoring.

After the way of use, the dams can be:

- Liabilities, used in a permanent or static mode (for chronic pollution);
- Assets, used in dynamic mode (for accidental pollution).

The passive ones, sometimes called stationary, have a fixed site in the film way, while the assets ones are used dynamically, driven by ships in various trawl systems.

After how the barrier effect is achieved (in fact, after working principle) dams can be:

- With fluid jets;
- With floating elements.

In their turn, dams with jets of fluid can be:

- With air jets;
- With surface water jets;
- With curtain of air bubbles, under the water.

About floating dams, by far the most used category, they can be:

- Rigid float floating dams (built);
- Inflatable floating dams;
- Auto inflatable floating dams;
- Fireproof dams;
- Off-hand dams

Technical and functional characteristics of floating dams

- Description:

Anti-oil floating dams are presented as a continuous curtain, so arranged:

The freeboard is the emersion, floating part, which does not allow the movement of the pollutant on water surface. In the end, the freeboard's aim is to permanently tracking the wave in providing the system's floatability**.**

The JUPA is the immersion part, which does not allow the movement of the pollutant in the water mass, under the dam.

The Ballast chain maintains the dam in a vertical position (to keep Jupa in lying position).

The section is a portion of a certain length of dam (to obtain a length of tens and hundreds of meters is necessary the coupling of multiple sections).

Quick coupler is a metal system which rapid joining several sections.

Anchors, cables for hauling or fixing is the auxiliary system which hauling or fixing the entire dam.

- Technical

The need for use in areas, conditions and different ways imposed the achievement of the dams in different range in terms of technical and dimensional characteristics.

As technical features can be listed:

Tensile strength - is the tensile strength at break of the system which function in both conditions static and dynamic

Weight/ meter - is the weight of the system: freeboard / Jupa / chain / compounds per meter:

UV resistance - is the material's resistance (constituting the freeboard and Jupa) to the action of UV radiation.

Characteristics of the dams should be correlated with hydro-meteorological operating conditions:

	Offshore		For shore and harbor		
Freeboard (mm)	1300	600	400	300	200
Jupa (mm)	1500	1100	600	500	300
Weight of ballast chain (kg/m)	36	17	6	5	4
Tensile strength (kN)	400	200	100	90	50
Maximum wave height (m)	6	4	3	1,5	0,5

Stabil in $curent_{maxim}$ (Nd)	3	2	2	2	2

- Functional features:

Functional characteristics are all limited parameters in which the system can work effectively;

Wave height (maximum) - is the maximum wave height (calculated from water surface) at which the dam does not allow the pollutant passing over it.

Flow Stability (max) - is the flow speed in which the dam remains upright and not allows to the pollutant to slip under Jupa.

Wind power (max) - is the maximum wind limit in which the dam resist in terms of tensile strength.

Temperature - the temperature limits within the dam material maintains its characteristics so they can resist and function efficiently.

Mod / storage space - is the volume that is occupied by dam when it is stored in the warehouse.

Location operation/ development position - is the amount of human and material effort and the time for mounting the dam in the working position.

- Materials used in dam construction:

Given the tough operating conditions presented and permanent contact with the oil, it is necessary to use "express materials" to build the dam, as follows:

Freeboard and Jupa - can be made of: Textile PES / PA coated with special rubber or PVC (flexible, do not rot, tensile strength, UV resistant, resistant to the action of oil, do not exfoliate; they are just a few required features).

- Rubber bands:
- Flame retardants;
- Sheet of steel.

Floating - can be made of polyethylene, polyester, cork, fiberglass, foam expanded, sheet of steel, fabric coated with rubber / PVC:

- The chain - can be made of galvanized steel, stainless steel, etc;Coupling - can be made of galvanized steel, stainless steel, fiberglass, etc;

In the attached presentation made in PowerPoint format are shown several representative types of floating dams, as follows:

- Rigid float floating dams (built)
- Rigid float floating dams (attached);
- Traction cable dam:
- Autogonflabile floating dams;
- Inflatable Floating dams;
- Fireproof dams;
- Off-hand dams.

The use of antipetrol dams

In order to limit the concentration (increasing the film thickness of pollutant) or reorientation of oil displacement in a certain direction, the dams can be passively or dynamically used.

a. The dynamic way is to tow (trawl) the dams on a route determined in advance. The success of such operations depends on tugs used. They must be strong enough and maneuverable that it can pull about 300-800 m of dam at speeds of around…..

Generally it is estimated that 1 CP of motor is equivalent to 20 kgf traction. Ships with two variable pitch propellers, type trawl fish are easier to handle. Towing ropes must have a minimum length of 50m. Classical towing systems are U, V, J, W type, boom device, each requiring a different number of ships.

The type of device is chosen depending on the width of the pollutant film front, its direction and speed and the amount of oil moving.

For reduced widths of the wave of pollution, with amount of oil spilled in small areas, devices with U or V booms will be used. For U and V devices, the distance between the two towing tugs can be at least 80 in

For greater widths of the pollutant film front, in the case of amounts of oil spilled on large surfaces, pliers device will be used, as it can have a large opening, almost the entire length of the dam used, compared with previous cases when about 1 / 2 the length of the dam held is used.

The type, length of the dam and trawl system will be chosen according to the polluted area, pollution front width and type of intervention ships. There are techniques to use "cascade" trawl systems, that consist of two or more moving formations (U, V or J) so that pollutants will be permanently directed toward the recovery area.

b. The passive mode is to position the dams on a fixed site in steady operation aiming to:

- Limitation of polluted areas – aiming to prevent the spread of the pollutant outside the polluted area by surrounding it with floating dams;
- Protection of areas / objectives - aiming to prevent pollution of vulnerable areas / industrial / water intakes, etc., by closing the area to be protected with floating dams
- Deflecting the pollutant wave in order to redirect the wave on a predetermined trajectory by positioning at an angle of dams, in the way of water movement driven by pollutant
- The pollutant concentration, in order to recover - is achieved by dam location (in the way of movement of the pollutant) on a site calculated such that crude oil pushed by the water current to focus on a certain area.

The dam type, its length, the anchor points are calculated based on the wind and current speed and the opening area / surface area to be protected / limited, as well as forecast hydro-weather conditions.

Calculation methods used to establish the necessary parameters for correct use of dams

The dams use is intended to limit the concentration (thickening of the oil film) and its orientation to established areas.

For this purpose, the anti-oil dams must not permit the passage of oil in any hydro-weather conditions of working.

Usually due to the hydro-weather conditions or misuse, the following phenomena may occur:

* because waves breaking, too high waves, or because of the inappropriate choice of type of dam according to real conditions, oil is trained above dam
* Due to anchoring, wrong positioning or balasting, the dam is not maintained invertical position, or does not create the bank sealing effect, the oil runs under it;
* Also, a too much water current trains the oil under the dam;
* Poor quality or defective coupling allow oil to pass through sections
* Accumulation of too much hydrocarbons in the recovery dam area (during trawling) can cause pollutant training under its skirt

To eliminate these shortcomings are needed the following:

- **The right choice** of the barrage on types/dimensions, correlated to the zone,the hydro-meteorological conditions, water's deep, way of use (always or not/ active or pasive), functional characteristics.

The tehnical characteristics of the the barrages must be correlated with the functional hydro-meteorological conditions:

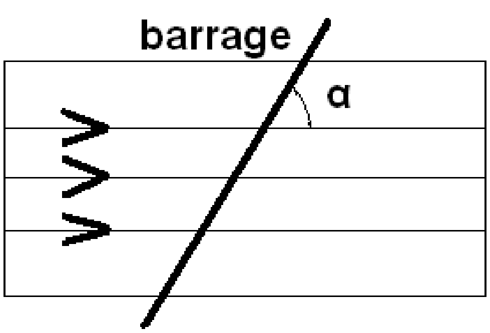
	Offshore		For coastal and harbour zone		
Free board (mm)	1300	600	400	300	200
Skirt(mm)	1500	1100	600	500	300
Weight of the ballast chain (kg/m)	36	17	6	5	4
Tensile strenght (kN)	400	200	100	90	50
Maximum height of the wave (m)	6	4	3	1,5	0,5
Stable in current$_{max}$ (Nd)	3	2	2	2	2

- **Arrangement in curent**

At a greater speed of the water current (when the barrage is towed to fast or when it is used in flowing waters) the oil slips beneaththe barrage. The maximum perpendicular curent on the barrage for which this is efficient has a value of aprox. 0.583Nd or 0.3m/s. For the case of flowing waters, with a current bigger than 1_5 Nd, the barrages are mounted at an angle so the module of perpendicular resultant of tthe speed on this to be smaller than 0.583 Nd.

The value of the setup angle of the barrage varies with the speed vector module of the current as it is showed in the following tabel:

Critical speed			
Speed curent		sin α	α (°)
knots	m/s		
0.583	0.30	1	90
0.7	0.36	0.833	56
0.9	0.46	0.652	41
1.1	0.57	0.526	32
1.3	0.67	0.448	27
1.5	0.77	0.390	23
1.7	0.88	0.341	20
1.9	0.98	0.306	18
2.1	1.08	0.278	16
2.3	1.18	0.254	15
2.5	1.29	0.233	13
2.7	1.39	0.216	12
2.9	1.49	0.201	12
3.5	1.80	0.167	10
4.5	2.32	0.129	7



The figure show the setup of a barrage at an angle α to the current lines. As the current speed increases with both the value of angle diminishes, and the lenght of the barrage go bigger.

- **The calculation of the forces that acts over a barrage (in current or in towed mode).**

When a barrage is used in a passive or dynamic way is necessary to know the forces that act on it, both for the choice of the constructive type that fits from the towing resistance point of view and for the establishment of the anchoring system or the towing force of the ship that tow the barrage.

On the barrage acts both the current with speed V_c, force F_c, and the wind with a force F_v. The total force F that acts over the barrage results by adding the vectors of the those two frces.

The calculation of the towing force that acts over barrage:

$F=F_c+F_v$, $F_c=kxA_sxV_c^2$, $F_v=kxA_ax(V_v/40)^2$; where:

F= total force (kgf);

F_c=the force of the water current over the submerged part of the barrage (kgf);

F_v=The force of the wind over the emersion part of the barrage (kgf);

A_s= the surface submerse (m^2);

v_c= speed of the water current (Nd);

k= proportionality constant = 26

A_a= the surface of the emersion part of the barrage (m^2);

V_v= wind peed (Nd)

In conclusion for a 100m barrage having:

Emersion lenght= 0.6 m;

Submerged lenght= 1 m; that works in the following conditions:

Current speed = 0.4 Nd, on the same direction with the vector

Wind speed = 20 Nd

We obtain a total force of:

$F= 26[100x1x0.4^2 + 100x0.6x(20/40)^2]=806$ kgf.

The anchoring force is different, depending on the type of the water bottom on which it is launched:

Anchor Weight (kg)	Mud	Sand	Clay
15	200	250	300

25	350	400	500
35	600	700	700

Choosing criteria for the barrages, depend on factors like:

Hydrocarbon retention capacity :

- the capacity to follow the wave;
- the capacity to stop hydrocarbons to slip under or over the barrage;
- the ability to stay vertical.

Reliability criteria:

- resistance to the tough conditions of maritim environment
- resistance to tear a part;
- resistance to UV, temperature, friction and hydrocarbon chemical action .

Use criteria:

- constructive parameters;
- functioning parameters
- transport conditions;
- operational support;
- personal and logistics;
- handling;

Purchase and mentainance costs:

- purchase price;
- costs regarding the washing, drying and storage.

The selection of a barrage type needed to an user can be done according to a matrix presented in a table.

The use of the matrix, favor the right selection of the barrage type according with: the zone and working conditions, the operational performances and maintenance characterics for each user.

the matrix can be used both in purchase phase and inexploitation phase of the barrages.

According to the quality of the response that can be offered by the specific situations, every type of barrage has been scored from 1 to 3, 1 represent maximum score . By adding the appropiate score for each type of barrages it is obtained a certain score. In the end it can be selected the barrage that obtained the lowest score.