INDUSTRIAL AND LOGISTICS ACCIDENTS - CASE STUDY

STUDY 7/A - NORMAL SYSTEM

1. STARTING POSITION

In the event of a leak in a refinery, chemical or processing plant environment, the primary risk is rapid contamination of concrete surfaces, channels and drainage systems, as well as the spread of contamination **through secondary waterways**. Leaks typically result from failures in pipes, tanks, valves or pumps and can be continuous or intermittent in nature, making early detection and targeted intervention difficult.



The situation is aggravated by the following factors:

- The porous and microcracked structure of the concrete, which promotes capillary infiltration of the oil, its permanent adhesion and the appearance of the surface as a "secondary emitter" (re-contamination);
- Proximity to sewers and drainage systems that can quickly carry pollution over long distances (especially in rainy weather or in the presence of process water);
- Environmental sensitivity, especially in the case of groundwater or surface water exposure;
- The need to maintain continuous operation, which limits long downtime and interventions involving large demolition.

The main objective is to protect concrete and drainage systems, prevent the spread of pollution and ensure compliance in accordance with the EU IPPC/IED (Integrated Pollution Prevention and Reduction) principle and compliance with OSHA and related environmental regulations. Reference event: the 2015 Refugio oil spill (USA), where around 400 m³ of oil was released into the environment as a result of pipeline damage, affecting industrial surfaces and water systems; the cost of the total remediation exceeded USD 96 million, after more than two years of recultivation.

2. NATURE OF POLLUTION

- Oil infiltration into microcracks and pores of concrete (typical penetration rate: 0.05 to 0.2 m/h, depending on concrete quality and crack network);
- An oil film formed in canals and drains that spreads with the flow of water;
- Accumulation of polycyclic aromatic hydrocarbons (PAHs) and other toxic components in the surface layer and sludge fraction;
- Secondary pollution through runoff and technological wash waters;
- Long-term adhesion and "resolution": aerated concrete can also release oily components later, especially during temperature fluctuations or cleaning cycles.

The pollutant is typically refined oil or chemical products that are hydrophobic in nature, adhere strongly to concrete and can cause structural damage in the long term (surface erosion, loss of adhesion, undercoating of coatings; concrete erosion up to 10-20%).

3. TRADITIONAL METHODS OF INTERVENTION

3.1 Localization

- Physical barriers (sandbags, temporary barriers),
- Shut-off valves, emergency shutdown.

Limitations:

- Barriers do not protect against microcracks and capillary suction of concrete;
- Efficiency is typically 60–80%, highly conditional;

- Installation time is 30-60 minutes, during which the contamination spreads further and can be incorporated into the concrete.

3.2 Surface removal

- Mechanical suction or dredging,
- Dispersion of absorbent materials.

Absorbents used: perlite (3-5×), zeolite, vermiculite, PP-based materials.
Limitations:

- Water saturation → a 30-50% decrease in efficiency, especially in sewers;
- In case of dredging, damage to the concrete surface;
- Large amount of waste (5-10× is the mass of contaminated oil).

3.3 Surface and structure treatment

- High pressure washing,
- Bioremediation or chemical treatment.

Limitations:

- During washing, the oil can spread and get into the drain;
- Bioremediation slow (months);
- The cost of chemical treatment is 200-500 EUR/m² and it has limited use in a factory environment.

4. OPERATIONAL CHALLENGES

- Pressure to react quickly;
- Coordination of several actors (HSE, operation, authority, remediators);
- Complex logistics with operational operation;
- High cost level (typically 1-10 M€ per incident).

RESULT 5 - NORMAL SYSTEM

- Partial protection (60-80%);
- Significant need for follow-up intervention (repeated cleaning cycles, surface repair, channel cleaning);
- High total cost;
- Long-term environmental risks (biodiversity loss of 20-40% in the affected areas).

STUDY 6/B - EXOLINE® OIL STOP

1. STARTING POSITION

The physical environment and the nature of the pollution are the same as in study 7/A. The aim of the intervention is complemented **by the active stabilization** of concrete and drainage systems, the **functional immobilization** of pollution and the prevention of its spread to secondary waterways.

Exoline® Oil Stop is used as a stand-alone oil binder, while improving the effectiveness of traditional absorbents and surface treatment methods.

2. POLLUTION MANAGEMENT LOGIC (upgraded system)

The essence of the improved system is that the handling of the oil **is not exclusively removal-oriented**, but **is based on the logic of** stabilization + immobilization + spread prevention:

- Hydrophobic, positively charged surface → fast oil phase coupling and "gripping";
- Mitigation of capillary suction of concrete, typically in the range of 50-70% (to be validated in a plant environment);
- Oil film stabilization in canals: reducing the mobility of the film so that it does not travel further towards water systems;
- The focus of the treatment is on structural stabilization and controlled removal, not just on washing.

3. IMPROVED INTERVENTION METHODS

3.1 Localization with Exoline®

- Traditional barriers unchanged,
- **Creation of zones enhanced with Exoline®** (e.g. perlite + 15-25% **Exoline®**), especially:
  - Concrete in surface "receiving zones" (in the vicinity of the point of damage),
  - At sewer inlets, gratings, sinkholes ("hot spots").

Result:

- Fast dispersion due to low specific gravity (≈0.65 kg/dm³) and fine particle size (>4 µm);
- Rapid immobilization in the absorption range of 8 to 12× mass
- Infiltration reduction ~70%;
- Structural protection of ~90% in terms of surface mobility, in particular by reducing migration towards drainage systems.

3.2 Surface removal - improvement of absorbents

Mechanism of action:

- **Exoline®** forms a hydrophobic protective layer and stabilized oil phase;
- Perlite and mineral absorbents are less likely to "soak", water absorption decreases;
- The bound oil is more stable, the backflow is reduced (especially on wet surfaces);
- A slightly alkaline pH (11.5-12.5) may contribute to the mitigation of acid corrosion processes (to be controlled according to the application environment).

Result:

- ~50% reduction in waste volume;
- Faster surface treatment and better collection;
- Spread reduction ~80%, especially in the direction of sewers and drainage.

3.3 Surface and structure treatment with Exoline®

- **Application of Exoline®** before washing, targeted at the pollution zone;
- Uniform topcoat and "interface stabilization" due to large specific surface area.
- Thermal stability up to 370°C: relevant in an operating environment in addition to heat stress and cleaning protocols.

Result:

- Reduction of toxic component mobility ~70%;
- Structural protection: reducing the amount of oil entering the concrete, reducing the subsequent "dissolution" of the surface;
- Reduction of ~90% of the mobility of surface pollution.

4. OPERATIONAL IMPACT

- Reaction time 40-60% reduction (immobilization is faster, fewer "spread windows");
- Fewer parallel operations (localize + bind + remove can be merged);
- Simplified logistics, especially with continuous operation;
- Waste management costs ~50% reduction due to a smaller and more stable waste fraction.

RESULT 5 - IMPROVED SYSTEM

- Effective protection ~90%, especially in the control of sewer and drainage propagation;
- Faster recovery (shorter downtime);
- Lower total cost of ownership (~30% reduction in CO_2 load);
- Reduced long-term ecological impacts (biodiversity loss can be kept below 10-20%).

CONCLUDING REMARK (PROFESSIONAL, "STUDY-LIKE")

The study is a retrospective technological comparison of a type of event that has occurred. **Exoline® Oil Stop** was not used in the reference cases examined; the aim is to demonstrate the material improvement potential of existing industrial remediation practices, with a particular focus on mitigating capillary suction of concrete surfaces and controlling secondary propagation towards sewer and drainage systems.

It is recommended to launch pilot projects in real industrial environments, with the following objectively measurable endpoints:

- Oil penetration depth and residual oil content of concrete surface (sampling / surface analysis),
- Solubility and re-contamination frequency measured in the sewer system,
- Waste volume (kg) and waste oil/water content ratio,
- Intervention time and downtime (hours),
- Cost-benefit analysis (€/m² + total incident cost),
- Environmental compliance and documentation protocol (HSE/OSHA, IED/IPPC logic).

Based on the results of the validation, an **operational standard procedure** (SOP) can be developed, which determines the application dose, the combined absorbent ratio (e.g. perlite + 15-25% **Exoline®**), the protection of channel "hot spots" and the optimal process of collection and disposal.

Further research is proposed for the long-term stability of systems with hybrid mineral substrates (e.g. perlite/zeolite + **Exoline®**), especially on industrial concrete surfaces, with repetitive leakage cycles and cleaning protocols.