

Causes and Consequences of Fire Emergencies on Oil and Gas Platforms

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Abstract

This study presents an analysis of the causes and consequences of the largest offshore platform accidents associated with oil and gas production. The research on this problem allows improving the reliability of risk assessment associated with offshore oil and gas production, as well as developing methods for improving the fire safety of oil and gas platforms under various operating conditions.

Key-words: Accident, Emergency, Fire Safety.

1. Introduction

Ensuring fire safety on oil and gas platforms is currently an urgent issue due to the increased fire hazard of these facilities. Offshore oil and gas production is a highly hazardous production activity. The technological processes and flammable substances turnover characterize oil and gas platforms as dangerous industrial objects. The location of oil and gas platforms creates additional difficulties in ensuring their fire safety due to the intensive influence of internal and external aggressive environment and other negative factors on the main structural elements (Adams 1992; Lisanov & Simakin 2008).

There have been several major accidents with catastrophic consequences in the global history of continental shelf development due to the low level of preparedness of oil and gas platforms and their operating personnel for extreme operating conditions (Det Norske Veritas 2007).

2. Results

To identify the main problems in ensuring the fire safety of oil and gas platforms and their resilience to various adverse factors, the consequences of major accidents at such facilities are presented in Table 1.

Table 1- Major accidents on offshore oil and gas platforms

Date and place	Type of accident	A brief description of the accident and the main causes	Number of casualties and damage
3 June 1979 Gulf of Mexico	Platform collapse, explosion, fire, oil spill	Oil spill followed by inflammation and explosion after contact with gaseous fumes from the engine powering the derrick on the platform	Completely collapsed platform and enormous environmental damage — about 120,000 tonnes of oil settled on the bottom of the Gulf
27 March 1980 North Sea	Platform collapse, fire, explosion	As a result of the strong storm wind, one of the five supporting structures collapsed due to deterioration. Further damage caused the platform to overturn with subsequent fire and explosion	123 casualties, damage — completely collapsed platform
6 July 1988 North Sea	Explosion, fire, platform collapse	During operations in the gas field, a series of consecutive pipeline explosions occurred, resulting in a fire and further collapse of the platform	164 casualties, completely collapsed platform
21 August 2009 Timor Sea	Fire, oil spill	There was a release of oil and gas from the well during drilling operations, followed by a fire	Oil spillage of up to 90,000 km ² . No casualties
20 April 2010 Gulf of Mexico	Explosion, fire, oil spill	Pressurized gas escaped onto the deck of the platform with a subsequent explosion and fire. This is the biggest environmental disaster in the history of offshore oil and gas production	11 casualties, spillage of more than 4 million barrels of oil into the Gulf, platform completely collapsed

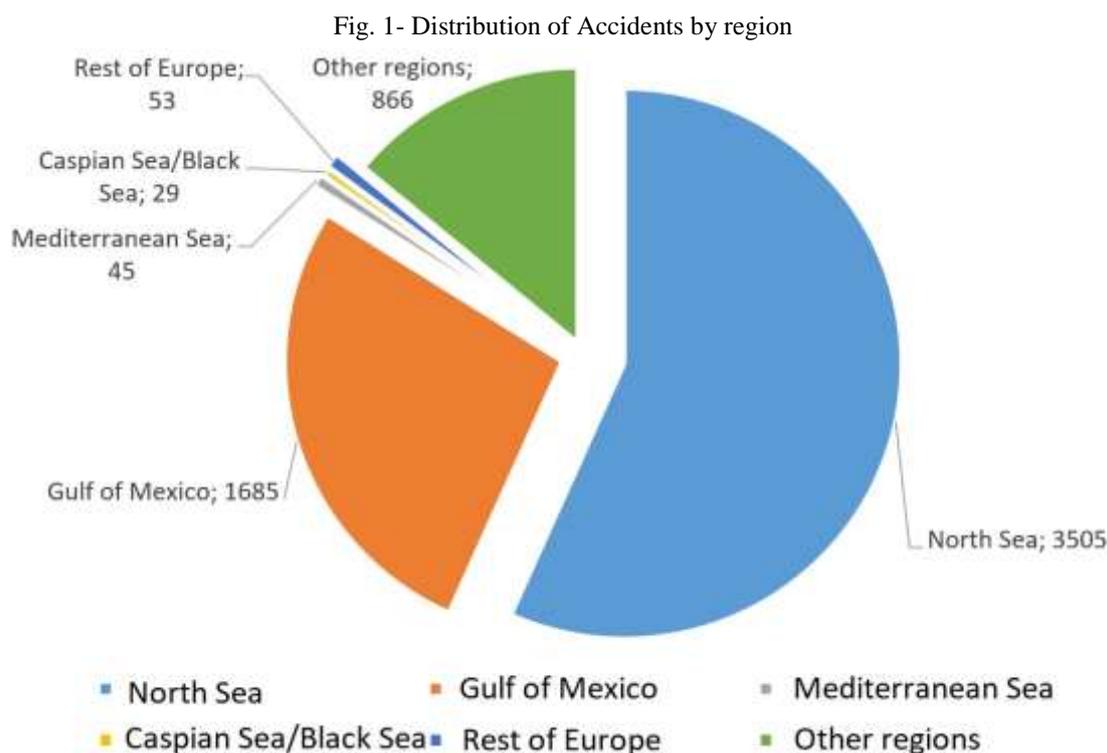
These examples show that accidents on offshore oil and gas platforms are almost always accompanied by many human casualties due to the vulnerability of personnel to the high-temperature effects of fire and toxic products of combustion. The negative impact on people is magnified many

times over by the limited space on the platform and, thus, the difficulty of evacuation (Dzhafarov et al. 2018; Lisanov et al. 2010).

The general analysis of the data in Table 1 allows us to conclude that the risk of accidents at oil and gas platforms with catastrophic consequences has decreased to some extent at present. However, individual accidents at such oil and gas facilities demonstrate the possibility of causing huge material damage and large-scale environmental damage almost at any time regardless of the constant improvement and development of offshore hydrocarbon production technologies.

A general analysis of known accidents at offshore oil and gas fields allows grouping accidents by regions (Fig. 1):

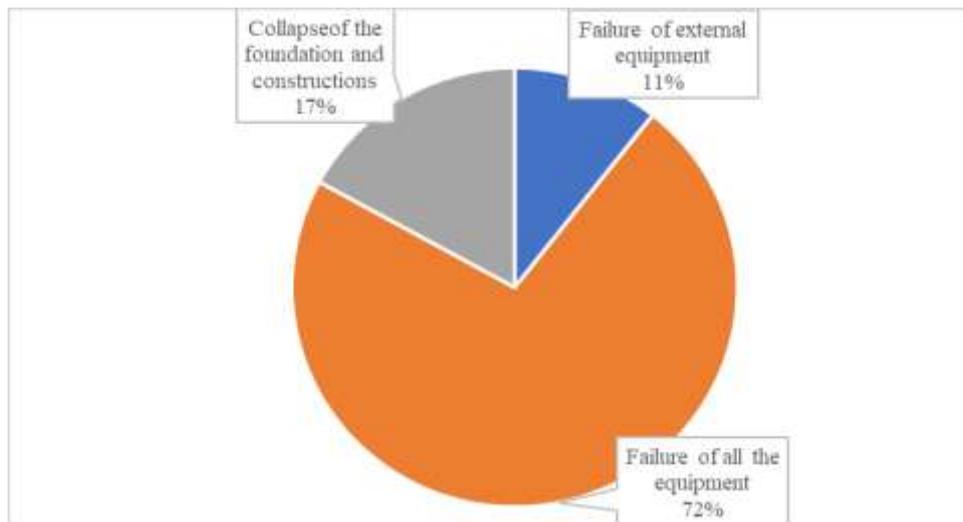
- North Sea;
- Gulf of Mexico;
- Mediterranean Sea;
- Caspian Sea/Black Sea;
- Rest of Europe;
- Other regions.



Oil and gas platform accidents can also be classified according to several causal indicators (Fig. 2):

- Collapse of the platform foundations and structures;
- Failure of a particular piece of equipment;
- Failure of all equipment.

Fig. 2- Causes of Accidents on Oil and Gas Platforms



Oil and gas platforms are characterized by an exceptionally high accident rate when drilling wells. An accidental well blowout is one of the most dangerous accidents on drilling rigs, leading to the collapse of entire offshore platforms.

3. Discussion

According to the results, we conclude that the main physical manifestations of accidents and their accompanying associated hazards on oil and gas platforms are:

- Gas leaks during drilling of wells, as well as at the stage of operation, including gas inflammation;
- Bursting of oil or gas pipelines undivided, destruction of containers, apparatus, tanks with natural gas under pressure with emission, including gas inflammation and formation of jet flame;

- Leakage of natural gas into rooms with the formation of an explosive mixture, its inflammation and explosive transformation;
- Explosion of fuel mixture in the tanks with gas condensate and diesel fuel with subsequent spillage, inflammation of flammable liquids, and burning in the form of a spill fire with the following casualties spreading near the accident place: shards and parts of the containers, apparatus, direct flame effect, and high-temperature effect;
- Leakage of flammable liquid (fuel, oil, methanol) from containers, tanks, and pipelines with the formation of a puddle of the spill and further inflammation from an inflammation source or by self-inflammation.

Major accidents in the history of offshore oil and gas production play a crucial role in the process of studying the problem of ensuring their fire safety. Based on the study of these accident scenarios, the probability of occurrence of each stage of accidents and minimize the risks can be established. It can help to reduce the material and environmental damage and the loss of life in case of new emergencies on oil and gas platforms (Akterskii et al. 2019).

Based on the conducted analysis, we can determine the main shortcomings in ensuring fire safety of oil and gas platforms:

- High level of fire hazards in technological processes of offshore oil and gas production;
- Low level of fire safety assurance (prevention of fires, maintaining structural integrity, safe evacuation routes);
- Low level of staff training for potential risks;
- Lack of practical skills of personnel in case of fire.
- Considering the high level of fire hazards at these facilities, the following recommendations can be offered:
- The necessity to develop international coordination for the collection and exchange of information on accidents at offshore oil and gas production facilities in a single agreed format;
- Particular attention should be paid to oil spills, and specifically to rapid response measures for preventing environmental disasters;
- Comprehensive improvement in the fire resistance limits of oil and gas platform carriers is needed to increase the time to safely evacuate people and increase the probability of preserving the integrity of the platform (avoiding collapse).

4. Conclusion

Offshore oil and gas platforms are hazardous production facilities. Therefore, a new system for ensuring safety at these facilities should be developed, and regular inspections and audits should be carried out.

The conducted analytical review and analysis of emergencies with fires and explosions at the offshore oil and gas platforms lead to the conclusion about high relevance of the scientific problem of searching new ways and methods of ensuring the required level of fire safety of these objects under the current extreme conditions of their operation.

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