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Цистерны

Вакуумные цистерны для отходов: взрывозащита неэлектрического оборудования

Передано правительством Германии* ** ***

Введение

1. На последней сессии WP.15 (Женева, 10–13 ноября 2020 года) Германия представила неофициальный документ INF.6, в котором описывается проблема взрывозащиты неэлектрического оборудования на вакуумных цистернах для отходов. В ходе обсуждения выяснилось, что для подробной дискуссии требуется опыт Рабочей группы по цистернам Совместного совещания. Представитель Германии принял к сведению замечания, высказанные в ходе сессии, и заявил, что он представит официальный документ Совместному совещанию для рассмотрения в рамках Рабочей группы по цистернам. См. также пункт 53 доклада о работе указанной сессии (ECE/TRANS/WP.15/251).

2. В качестве дополнения к прилагаемому неофициальному документу INF.6 в настоящем документе вновь кратко излагаются основные элементы комплексного вопроса о взрывозащите неэлектрического оборудования на вакуумных цистернах для отходов.

3. Для вакуумных цистерн, предназначенных для легковоспламеняющихся отходов, ДОПОГ предписывает различные методы обеспечения взрывозащиты неэлектрического оборудования за счет конструкции в условиях присутствия взрывоопасной атмосферы. Если состав смеси легковоспламеняющихся отходов класса 3 точно не известен, то в случае сомнений должна назначаться зона 0. В результате этой классификации все части системы вакуумной цистерны для отходов должны иметь высокую степень свободы от источников воспламенения.

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*** Настоящий документ был запланирован к изданию после установленного срока в силу обстоятельств, не зависящих от представившей его стороны.

4. В соответствии с пунктом 6.10.3.8 b) МПОГ/ДОПОГ,

a. цистерна может быть устойчивой к ударному давлению взрыва;

b. могут использоваться насосы, которые в силу своей конструкции не способны вызывать образование искр;

c. насосы, не отвечающие этому требованию, должны быть надлежащим образом защищены с помощью пламепрерывающего устройства.

5. В этой связи можно сделать вывод, что цистерна необязательно должна быть устойчивой к ударному давлению взрыва или оснащена пламепрерывающими устройствами, если используются насосы, которые в силу своей конструкции не способны вызывать образование искр (случай, указанный в пункте 4 b.). Как правило, для выполнения этого требования безопасности используются жидкостно-кольцевые вакуумные насосы.

6. Возникает вопрос, как доказать, что эти типы насосов не вызывают образование искр.

a. В Германии для этих целей используются насосы категории 1 согласно директиве 2014/34/EU (ATEX) (взрывозащита электрического оборудования).

b. Для оценки взрывозащиты недостаточно рассматривать только внутреннюю часть насоса; должна быть оценена вся система насоса/цистерны, т. е. вся внутренняя взрывозащита.

c. Благодаря их конструкции в жидкостно-кольцевых вакуумных насосах имеется жидкостное кольцо, которое предотвращает образование потенциальных искр. Однако эта защитная функция работает только в том случае, если наличие жидкостного кольца может быть гарантировано при любых условиях эксплуатации. Однако жидкостно-кольцевые вакуумные насосы в силу своей конструкции свободны от искр не при всех условиях эксплуатации. Следовательно, отсутствие искр может быть обеспечено только путем контроля жидкостного кольца. Необходимо рассмотреть два следующих сценария:

i. фаза запуска насоса, во время которой сначала должно быть сформировано защитное жидкостное кольцо;

ii. потеря жидкости во время работы.

7. Для решения проблемы предлагается провести оценку опасности воспламенения от неэлектрических источников воспламенения на основе международного стандарта. Это соответствует стандарту в отношении взрывозащиты электрического оборудования. Стандарт ISO 80079-36/37 допускает оценку неэлектрических источников воспламенения в системе вакуумно-нагнетательного насоса и системе вакуумной цистерны для отходов.

8. Для достижения целей защиты, установленных в стандарте ISO 80079-36/37, необходимо проводить избыточный мониторинг уровня жидкости для получения положительной оценки в соответствии со стандартом ISO 80079-36/37.

9. В прилагаемом неофициальном документе INF.6 содержится подробный анализ и точное изложение проблемы.

Предложение

10. В этой связи в соответствии с требованиями в отношении взрывозащиты электрического оборудования предлагается включить в пункт 9.7.8.2 ДОПОГ после третьего предложения следующий текст:

«1. Неэлектрическое оборудование, имеющееся на вакуумных цистернах для отходов (глава 6.10), расположенное в зонах, в которых существует или может существовать взрывоопасная атмосфера в концентрациях, требующих принятия

особых мер предосторожности, должно быть подходящим для использования в опасной зоне. То же самое относится и к неэлектрическому оборудованию, через которое переносится взрывоопасная атмосфера.

2. Такое оборудование должно отвечать общим требованиям стандарта ISO 80079-36/37. Должны выполняться требования в отношении неэлектрического оборудования соответствующей группы и соответствующего температурного класса в зависимости от веществ, которые будут перевозиться.».

Annex [English only]

INF.6 (9–13 November 2020)

Interpretation of the requirements for vacuum operated waste tanks

Transmitted by the Government of Germany

Introduction

1. The Working Party may wish to discuss the following questions. If the working party agrees, the problem will be put to an official working paper for the next session.

2. The carriage of flammable wastes in vacuum-operated tanks has to meet/is subject to the requirements regarding the use of vacuum pumps/exhauster units set out in 6.10.3.8 (b) of ADR.

3. 6.10.3.8

"The tanks shall be fitted with the following additional service equipment:"

> 6.10.3.8 b)
>
> "A device to prevent immediate passage of flame shall be fitted to all openings of a vacuum pump/exhauster unit which may provide a source of ignition and which is fitted on a tank used for the carriage of flammable wastes, or the tank shall be explosion pressure shock resistant, which means being capable of withstanding without leakage, but allowing deformation, an explosion resulting from the passage of the flame;"

4. Conversely, this means that a vacuum-operated tank that is equipped with a vacuum pump that does not provide a source of ignition does not have to be explosion pressure shock resistant and does also not have to be fitted with devices to prevent immediate passage of flame.

5. In most cases, so-called liquid ring vacuum pumps (LRVP) for which the manufacturer confirms that they do not provide a source of ignition are currently used. In Europe, this confirmation is usually based on the categorisation of this pump into equipment category 2 in accordance with Directive 2014/34/EU (ATEX). It is thus by an attestation of conformity that the manufacturer declares that the requirements relating to equipment and protective systems intended for use in potentially explosive atmospheres are met.

6. For various reasons, this is not sufficient.

7. As wastes are usually mixtures of substances which are largely unknown, it is almost impossible to provide reliable safety-related data on the substances in the specific case.

8. In cases of doubt, the inside of the tank must always be classified as zone 0. The inside of the pipe connector of the pump, which is then directly in contact with zone 0, must thus be compliant with equipment category 1.

9. As a consequence, only those pumps that are compliant with equipment category 1 for zone 0 on the inside of the mounting flange, and with equipment category 2 for zone 1 on the outside can be used in vacuum-operated tanks.

10. The following facts should be considered to meet the requirements set out in 6.10.3.8 (b) of ADR:

a) During the assessment, not only the pump should be taken into consideration, but also the associated sensor and control technology, the piston, the openable end and other potential sources of ignition.

b) For the assessment, it is not imperative that the ATEX Directive with its indication of zones and categories be applied, as this is not explicitly required in ADR (6.10.3.8 (b)). Here, it would be sufficient and likely to achieve results if the compliance was proven in accordance with ISO standard 80079-36:2016 (Explosive atmospheres - Part 36: Non-electrical equipment for explosive atmospheres - Basic method and requirements). Especially since 9.7.8 of ADR already regulates explosion protection for electrical equipment on vehicles by referencing the corresponding IEC 60079. Furthermore, the zones for both the inside of the tank and the immediate surroundings are already defined there. Therefore, the procedure described above would be a systematic and coherent approach.

c) For liquid ring vacuum pumps, the technical and formal efforts required to comply with ISO 80079-36:2016 are relatively manageable. However, demonstrating the compliance of multi-cell vacuum pumps requires greater effort.

Specification

11. Studies on whether it is necessary to flesh out the explosion protection requirements to be met by vacuum pumps/exhauster units in vacuum-operated waste tanks found that despite already existing high standards it cannot be generally ruled out that, in certain modes of operation of the LRVP, scenarios in which effective sources of ignition occur are to be expected. Only scenarios of explosion protection for non-electrical equipment are to be taken into consideration.

12. To address this situation appropriately, it would make sense to introduce a procedure for analysing such potential operating states (explosion protection scheme). This procedure should be standardised to ensure a level playing field and transparency.

13. Different standards exist at the national, European and global level.

14. In keeping with the dangerous goods provisions (ADR), an internationally standardised procedure (also beyond Europe) should be favoured.

15. The provisions already include such a standardisation regarding explosion protection for electrical equipment. Part 9 of ADR regarding the vehicle equipment refers to IEC 60079 in 9.7.8.2. The classification of zones that is already contained in 9.7.8.2 of ADR is based on this IEC standard.

16. The equivalent of IEC 60079 with regard to explosion protection for non-electrical equipment is ISO 80079-36/37, which already refers to IEC 60079, for instance concerning categorisation and the classification of zones. The same standards should apply to ensure harmonisation. It would thus be appropriate and transparent to introduce a reference to ISO 80079-36 and ISO 80079-37 in ADR for the assessment of explosion protection for non-electrical equipment in vacuum-operated waste tanks.

17. ISO 80079-36 and ISO 80079-37 already contain provisions on requirements for the technical documentation and leave compliance with the documentation to the manufacturer.

Background / specification of the problem

18. When waste is sucked into the collection tank of the vacuum-operated tank-vehicle, it has to be expected during operation that a dangerous explosive atmosphere forms and is conveyed through the LRVP. The probability of dangerous explosive atmosphere forming during operation stands almost at 100 percent. Therefore, this atmosphere is to be classified as zone 0 in accordance with Directive 1999/92/EC (transposed by the Dangerous Chemicals Ordinance into German law). As a consequence, all items of equipment fitted to the vacuum-operated tank-vehicle that are in contact with this dangerous explosive atmosphere must be to a very high degree free from sources of ignition. In accordance with Directive 2014/34/EU, equipment of equipment category 1 or, in accordance with ISO 80079-36, equipment with EPL Ga (equipment protection level) would be required. For the used sensors, this requirement is to be met by using suitable explosion-proof equipment.

19. The LRVP is a turbomachine and is to be considered mechanical equipment. Since there are no internationally applicable standards for such vacuum pumps, it is only possible to assess them on the basis of standards ISO 80079-36 and ISO 80079-37, which both exists as harmonised EN standards, too. An LRPV essentially consists of a stator and a rotor that is eccentrically arranged within the stator. As a result of their function, it is necessary to leave very small gaps between the two components. Therefore, it can not be ruled out that the rotor and the stator will come into contact. As a consequence, mechanically created flashover and friction sparks may occur. The same applies if small particles, which can get stuck between the rotor and the stator, are sucked in together with the conveyed gas. Such flashover or friction sparks are to be avoided in so far as possible.

20. As a result of its function, the LRVP contains a liquid; in vacuum-operated tank-vehicles, this is usually water. Due to the movement of the rotor, centrifugal forces throw the liquid outwards so that it forms a liquid ring within the stator. This liquid ring covers all potential points of contact at which mechanically created flashover or friction sparks may occur in liquid, so that potential sparks are covered (and thus are not in contact with dangerous explosive atmosphere) and will be extinguished. It should be noted here that, during the process, liquid is always discharged together with the gas, so that liquid needs to be continuously fed in during operation.

21. In order to ensure that the pump is to a very high degree free from sources of ignition, this liquid ring must be guaranteed as reliably as possible. This can only be achieved through appropriate monitoring of the liquid in the ring. In accordance with ISO 80079-36 and ISO 80079-37, a control of ignition source of IPL 2 (ignition protection standard) is required to this end. This can usually be achieved through redundant monitoring devices.

22. In an LRVP, the gap between the rotor and the side walls is considered critical and needs to be very narrow. Therefore, it cannot be ruled out that the rotor comes in contact with a side wall. During operation, due to the rotation, a liquid ring is formed within the pump which may be considered a liquid immersion. During the process, all potential points of friction between the moving rotor and the fixed stator are covered in liquid and any contact between flammable vapours and gases and the potential points of contact is avoided. Thus, there is no risk of ignition. However, the start-up phase, during which the liquid ring is being created, remains problematic. For this purpose, when the pump is started, it must always be filled to more than half of the regular level. This needs to be monitored. However, if the pump is overfilled, it can fail due to an unacceptable rise in pressure. There are pumps that, even though they are regularly filled to the maximum level, withstand without damage the pressure that builds up during the start-up phase due to their structural design. In this case, it would apparently not be necessary to monitor the filling level, as described above, yet this still needs to be assessed.

23. During operation, liquid is discharged together with the gas flow. This would cause a loss of liquid within the pump. It could then no longer be guaranteed that the liquid ring will be maintained. It is thus imperative that liquid be continuously fed into the pump. The necessary liquid flow rate, which is to be defined by the manufacturer of the pump, must be monitored.

Proposal

24. As part of the assessment of whether the pump is free from any sources of ignition, ISO 80079-36 as well as ISO 80079-37 must be complied with in order to reach equipment category 1 in accordance with Directive 2014/34/EU. An LRVP for which adequate fluid intake during operation as well as an adequate level during the start-up phase is given is free from sources of ignition during normal operation, i.e. this, in principle, corresponds to category 3 in accordance with Directive 2014/34/EU. To reach the level of category 1, sources of ignition can be avoided by using monitoring devices, while IPL 2 (ignition protection level) must be applied. This ignition protection level can be achieved through redundant monitoring devices, i.e. the level of liquid before the start and the liquid flow rate during operation are to be monitored both in a redundant manner, while each monitoring operation should be compliant with SIL 1 (safety integrity level).

25. The ignition hazard assessment is to be limited to atmospheric conditions. Potentially explosive mixtures are only conveyed through the LRVP in suction mode. In suction mode, the interior of the LRVP and the other components is subject to negative pressure. However, during the discharge of the vacuum-operated tank in overpressure mode, only air from the surrounding environment, which is not explosive, is conveyed.

26. In the sludge tank, it has to be expected that explosive gases can evaporate. This needs to be assessed separately.

27. Non-electrical equipment that has been assessed in accordance with Directive 2014/34/EU and certified for a corresponding equipment category in accordance with the relevant zone can generally be used in vacuum-operated waste tank-vehicles. The conformity assessment in accordance with Directive 2014/34/EU is usually based on the requirements set out in ISO 80079-36 and ISO 80079-37. In accordance with this standard, it is also permitted to make an assessment based on the equipment protection level (EPL). Outside the EU, this is equivalent to the assessment in categories in accordance with Directive 2014/34/EU. (At the international level, ISO 80079-36 and IEC 60079-0 use the term "equipment protection level" (EPL)).

28. This procedure is similar to the existing practices in explosion protection for electrical equipment, where the assessment is generally based on IEC 60079.

Proposed wording

29. After the third sentence in 9.7.8.2 insert the following:

"Non-electrical equipment on vacuum-operated waste tanks (6.10), situated in areas where an explosive atmosphere is, or may be expected to be, present in such quantities as to require special precautions, shall be suitable for use in a hazardous area. The same applies to non-electrical equipment through which the explosive atmosphere is conveyed.

Such equipment shall meet the general requirements of standard ISO 80079-36/37. The requirements for the non-electrical apparatus of the relevant group and temperature class according to the substances to be carried shall be met."