Research Article

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Corrosion rate measurement for steel sheets of a fuel tank shell being in service

<https://doi.org/10.1515/eng-2021-0086>

received October 21, 2020; accepted August 06, 2021

Abstract: Some corrosion progress trends specific for cylindrical steel shells of typical above-ground fuel tanks are first identified experimentally and then quantitatively compared with one another. The inference is based on many random thickness measurements related to the selected corrosively weakened coating sheets and carried out at various moments of the tanks in question service time. It is shown in detail that in this type of structures, due to the manner of their use and, particularly, the material stored inside, the corrosion process is in general significantly accelerated over time. For this reason, a nonlinear formal model describing the simulated corrosion development anticipated for the future fuel tank service time seems to be the best choice in forecasting its remaining time to failure.

Keywords: fuel tank, steel tank shell, corrosion rate, durability prediction, *in situ* measurements, trend of corrosion progress

1 Introduction

Evaluation of the forecasted durability of the corroded steel tank used to store liquid petroleum products is counted as one of the basic duties of technical supervising personnel in fuel tank farms. Estimation of this type allows for a more efficient management of resources at the base through a more rational planning of possible repairs or other modernization or maintenance works of lesser importance. In general, durability is understood here as the safe service time of considered object, determined

under the assumption that no preventive actions or actions just slowing down the destruction progress are undertaken. This time should not be referred directly to the moment of the tank failure, resulting from the loss of capacity to bear the external loads applied to it, but to such point in its service life in which the failure probability will become unacceptably high. Under the conditions of standard operational regime, assuming full service load, durability of the tank shell is determined by the corrosion state of the steel sheets with which the tank shell is made. Tank shell durability determination algorithm may be reliable only when the durability will be treated as a random variable, for which probability distribution parameters shall be determined based on fully probabilistic analytical procedures [1–3]. Thus, first of all, maximum user accepted failure probability should be set, and in the second step, it will be compared with the values of analogous probability resulting from the appraisals of the technical condition of the tank under consideration. These appraisals should be performed after certain, predetermined, service time periods. If the person performing the appraisal has at least two statistical data sets, corresponding to two independent evaluations of the same steel sheet in two different times at his disposal, then under the assumption of constant service conditions, this person may attempt to model the statistical trend of corrosion changes for corresponding steel sheet. Knowledge of this trend, through extrapolation for coming service years, will allow for scientifically justified forecast of corrosion progress in the future. The randomness of the corrosion process, in association with the randomness due to the statistical distribution of yield limit for structural steel, of which the shell is made, allows for the estimation of random, decreasing in time, bearing capacity of the considered steel sheet. This bearing capacity should be compared with random effect of authoritative external loads combination. Such a comparison will allow for the determination of failure probability with reference to subsequent service periods of the considered tank. The time after which such probability, ever increasing with corrosion progressing during service, will reach the threshold value acceptable to the operator of the fuel tank farm will constitute the sought for measure of durability.

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A typical cylindrical shell of a steel on-the-ground tank used to store liquid petroleum products is usually made of several rings differing in thickness, the thinnest of which are located at the top, while the thickest ones are placed at the bottom near the tank floor. The rings, in terms of reliability analysis, form a classical serial system, as the weakest ring is authoritative when the bearing capacity of the whole shell is evaluated. However, this is not necessarily the ring exhibiting the lowest bearing capacity, as the ring strained to the highest, i.e., usually the thickest one, located at the bottom, is considered the weakest. This ring is affected by the highest hydrostatic pressure exerted by the liquid stored inside the tank. In the practically important design cases, due to the stepwise change of the shell thickness between neighboring rings, any of the intermediate rings, located above the bottom one, may also prove to be stressed the highest at a certain moment of service time. The authors' experience seems to indicate that, relatively frequently, after long-term service of the tank the bearing capacity of the shell becomes to be limited by the bearing capacity of one of the highest located rings, the one permanently bonded to the top stiffening ring. It is at this level, where at relatively low load in nooks and crannies created by many details difficult to protect, the potentially initiated corrosion seems to find the best conditions for growth.

Due to the inevitable corrosion process progressing in time, each shell layer has to be treated as an aging object in the sense of reliability theory. Depending on the tank service time, the loss in bearing capacity of such the layer is a consequence of not only decreasing thickness but also degrading changes occurring in the steel microstructure and intensified by the corrosion [4]. The quantitative evaluation of the changes of this type is so far difficult to ascertain. This means that an attempt at modelling of this phenomena requires at least an access to the expanded database of experimental results. For this reason, such influence is neglected in these considerations. Only the thickness of each of the coating sheets considered here is taken into account, which varies with the corrosion progress.

The purpose of the analysis presented here is an attempt to empirically verify whether the various types of trends, commonly used in computational models to estimate the forecasted durability of a tank and anticipating the future corrosion progress changes in the most stressed sheets of its shell, give a sufficiently reliable description of the degree of weakening of these sheets, related to the real local conditions and increasing during the tank use. In this study, the theoretical models used for conventional simulation of corrosion progress are

associated with the corresponding shell thickness results measured *in situ*, in the framework of the inventories of real fuel tanks located at one of the bases in southern Poland, carried out at different times of their service use. The authors' knowledge shows that the verification of this type has not been carried out so far. It is a well-known fact that similar analyzes have already been developed in the past, but they have been calibrated rather for the structures used in the marine environment, characterized by significantly higher aggressiveness and therefore giving much greater corrosion intensity. The conclusions obtained on their basis, in our opinion, do not have to be reliable for the durability prediction of the on-the-ground steel fuel tanks. It is also necessary to note that the corrosion progress in the steel tanks of this type has been inventoried and monitored, both in a quantitative and in a qualitative manner, in many other studies (for example in ref. [5]). These studies, however, are in general only the parts of more extensive considerations, ending with more general conclusions and thus difficult to interpret unequivocally.

2 The alternative corrosion progress models

In conventional design procedures related to the new above-ground steel fuel tanks with a shell load-bearing structure, it is generally assumed that during future service they will be subject to continuously weakening corrosive effects resulting in a monotonic reduction in load capacity. The progress of this process is most frequently anticipated as constant during the structure service time, which allows its unequivocal description using a simple linear model. In this approach, therefore, it is a one-parameter formal model in which the direction factor A (mm/year), independent of time, is the measure of the corrosion weakness of the coating sheet under consideration, caused by a corresponding decrease in its thickness [6–8]. This means that after time τ (years) from the time the tank was commissioned (τ_0), the representative thickness of the tested sheet t_τ (mm) will be smaller than the nominal thickness t_{nom} (mm) and will be equal to:

$$t_\tau = t_{\text{nom}} - A\tau \text{ (mm)}. \quad (1)$$

A relative corrosion loss related to the nominal plate thickness t_{nom} is assumed here, subject to the assumption that at the moment τ_0 , the equality $t_{\text{nom}} = m_t(\tau_0)$ was satisfied (m_t is a mean value taken from the measurements of a random thickness), as due to the mill

tolerances the real initial plate thickness could have been higher or lower than the nominal one with equal probability.

In practice, the linear (or possibly close to linear) development of the corrosion process occurs relatively rarely. Experimental studies carried out in this field usually show that such a process is most intense at the initial stage of use of the structure. Over time, a layer of corrosion products forms on the steel surface, which protects the element from its destructive influence. For this reason, for better precision and greater reliability of inference, the progress of corrosion process is often described by a power equation [9,10]. The forecasted decrease in coating thickness after τ years of use is then equal to:

$$\rho(\tau) = \frac{t_{\text{nom}} - t_{\tau}}{\tau} = A\tau^{\alpha}. \quad (2)$$

In such a formula, the exponent α indicates the effectiveness of the protective layer of corrosion products, while the factor A (mm/year) is the selected reference corrosion speed. Values α close to 0 indicate a strong weakening of the progress of corrosion processes. If $\alpha \approx 1$, the corrosion rate is constant in time. In this situation, corrosion products do not protect the structure in any way (Figure 1).

Calibration of the parameters used in power models has been performed among others in refs [11,12]. Yamamoto treated the corrosion progress as a random variable with probability density characterized by Weibull distribution [13]. The following research allowed for development of more extensive, multistage power models (mainly four stage models) described, for instance, in refs [14–16], but verified on data sets concerning corrosion of ship plates

generated by the action of salty and contaminated sea water.

3 Identification of local corrosion progress trends and their extrapolation for the future

Steel tanks adapted to the liquid fuels storage belong to the basic structures used in the petrochemical industry. Due to the manner of their use and, particularly, the type of a material stored inside, specific hazards are identified for them, first associated with the risk of initiating a potential corrosion process and then with its intensification increasing over time [17–20]. The basic tasks in the scope of supervision over the technical condition of a fuel tank being in service include periodic inspection of the shell of such a tank for the location of possible corrosion damage and, if detected, assessment of the level of its advancement. The nondestructive evaluation technique commonly used to monitor the corrosive weakening of steel sheets is in this case the ultrasonic method. In zones with even or uneven corrosion influence, this type of testing consists of many spot wall thickness measurements on a properly selected measuring grid. The average and also the extremum (i.e., both minimum and maximum) values are then determined locally from the results obtained in this way. Of course, when the measurements are accompanied by randomly located corrosion pits, such a planned test technique based on evenly spaced measuring points does not lead to the quantitatively right results. It should be emphasized, however, that the possible detection of a local domain of pitting corrosion, which generates a significant risk of loss of tightness of the tank shell, always involves the need for immediate technical intervention. The tank user never waits for full perforation of the tank wall. Much earlier, he/she orders the repair of the detected damage, for example, by removing smaller pits by means of welding, replacing damaged sheets or, sometimes, strengthening them by using an overlay. Due to such activities, early detected and effectively neutralized local pitting corrosion is generally not critical in the global assessment of the corrosion resistance of a steel tank shell being in service. In general, rather uniform corrosion is unequivocal in this field, which can sometimes turn into the adjacent zones with corrosion which seems to be extensively uneven.

In practice, the inventory of the progress of such corrosion is made in Poland, in accordance with the

Figure 1: Increase of the sheet thickness corrosion loss described by the equation (2) assuming that $A = 0.04$ (mm/year).

appropriate standard recommendations [21], for each selected sheet of a tank shell in question, at five characteristic points located in the geometric center of this sheet as well as in its four corners, respectively. Cyclical, every few years, repetition of the inventory of this type gives the opportunity to collect a homogeneous population of statistical data monitoring changes in random thickness of considered steel sheets, referred at different time-points but to the same points located on the same sheets in the shell of the same tank. Appropriate organization of such a set of empirical data enables the determination of each considered measuring point of a statistical trend describing the progress of corrosion to date, and then extrapolating this trend to the future. It is only necessary to assume that the way the tank is used and the conditions determining the aggressiveness of the environment in its immediate surroundings will not change and also that it will not be modernized at that time in any way.

Extrapolation of the statistical trend of corrosion progress, previously empirically verified at a given measuring point, to the future use of the tank in question may prove to be a formally trivial task if only a linear or at least a quasi-linear trend will be identified independently. Nevertheless, if other trend of this kind, based also on the independent empirical measurements, will be identified in this analysis, especially the power one described by the equation (2), this approach may give the forecasts not very precise and thus not entirely reliable. Let us note, however, that if in equation (2) the inequality $\alpha \leq 1$ is true and also if the slope of the empirically verified trend described as a linear one is determined on the basis of data completed just at the time of the tank testing (i.e., at time-point τ_i – see Figure 1), the linear extrapolation will always give a safe predictive estimate.

4 Characteristics of the fuel tanks selected for testing

In order to provide a detailed understanding of the typical progress trend of the corrosive process, the one which would be representative for conventional steel fuel tanks, four above-ground floating roof tanks were selected for measurements, located in one of the fuel bases in southern part of Poland. The volume of tanks number 1 and number 2 was equal to $V = 5,000 \text{ m}^3$, their diameter (D) = 24.62 m, and their height (H) = 11.80 m (Figure 2), while in the case of tanks number 3 and

Figure 2: General view of the tested tank number 1 with the sprinkler system installed at the top.

number 4 the volume was equal to $V = 2,000 \text{ m}^3$, the diameter (D) = 16.70 m, and the height (H) = 10.46 m, respectively.

All tested tanks were put into service in 1975. Sheet thickness measurements were made after over 30 years of use of each of the tested tanks (i.e., mainly in 2007) using an ultrasonic thickness gauge with an accuracy of 0.1 mm or even, in some cases, 0.01 mm. For comparative purposes, the obtained results have been combined with the archival ones available to the authors and derived from previous thickness measurements carried out at analogous points of the same sheets.

In Figure 3, one of the shell zones of tank number 1 with initiated corrosion penetrating steel, of a uniform nature, is shown in detail.

5 Detailed comparative analysis of measurement results

A detailed list of measurement results corresponding to individual tanks described in the previous chapter of this

Figure 3: One of the shell zones of tank number 1 with even corrosion influence, locally identified.

Table 1: Sheet thicknesses measured at different times in different locations of the tank number 1 steel shell

Part of the tank shell	t_{nom} (mm)	Measurements taken in a year (mm)		
		1995	2006	2007
Bottom-middle part	6		5.1–5.7 (5.47)	5.2–5.9 (5.56)
Bottom-peripheral ring	8		7.2–7.8 (7.58)	7.1–7.8 (7.50)
First coating sheet	11	11.0–11.2 (11.1)	10.1–10.9 (10.54)	10.1–10.9 (10.59)
Second coating sheet	9	8.8–9.2 (9.0)	8.1–8.9 (8.42)	
Third coating sheet	8	7.9–8.1 (8.0)	6.9–7.8 (7.4)	
Fourth coating sheet	7	7.0–7.1 (7.05)	6.1–6.8 (6.38)	
Fifth coating sheet	7		6.2–6.7 (6.39)	
Sixth coating sheet	7		6.1–6.6 (6.3)	
Seventh coating sheet	7		6.2–6.7 (6.42)	
Eighth coating sheet	7		5.9–6.9 (6.36)	
Roof-central plate	5	4.4–5.3 (4.94)	4.1–4.8 (4.35)	
Roof-cover over the pontoon	5		4.2–4.8 (4.55)	
Roof-pontoon	5		4.0–4.9 (4.34)	

work is given in Tables 1–4. The maximum as well as the minimum thicknesses of corroded shell sheets, measured at particular locations and at different times, are summarized in them and compared one to the other.

Each pair of such values thus determines in these tables the range of variability of a corroded sheet thickness at a given coating location. It is accompanied, for comparative purposes, by the average value calculated for this location and written in brackets.

In addition, for some of the tested tanks and for selected locations of steel coating corresponding to these tanks, in order to better illustrate the variability of the results obtained, all the measurements taken in each place are summarized in Figures 4–6. The location and also the designation of measuring points in individual

sheets are shown in detail in Figure 7 with regard to the example of one selected coating segment. The measurement results shown in it are related to the initial nominal sheet thickness given on the left.

As can be seen, in many locations, probably as a result of rolling tolerances, or even of some repair works carried out previously, the thickness of the sheets potentially weakened by corrosion, even after 32 years of using the tank, still proved to be greater than the appropriate nominal thickness resulting from the technical design.

Histograms presented in Figures 8–12 facilitate the inference regarding statistical random variability of the considered coating sheet thickness. The random nature of such thickness is largely generated by the corrosion weakening increasing in time.

Table 2: Sheet thicknesses measured at different times in different locations of the tank number 2 steel shell

Part of the tank shell	t_{nom} (mm)	Measurements taken in a year (mm)		
		1994	2001	2007
Bottom-middle part	6		5.56–6.22 (5.85)	5.0–5.8 (5.59)
Bottom-peripheral ring	8		6.62–7.85 (7.18)	
First coating sheet	11	11.0–11.2 (11.1)	10.4–11.32 (10.75)	10.4–11.2 (10.69)
Second coating sheet	9		8.43–8.77 (8.64)	
Third coating sheet	8		7.52–7.78 (7.62)	
Fourth coating sheet	7		6.42–6.79 (6.61)	
Fifth coating sheet	7		6.59–6.92 (6.79)	
Sixth coating sheet	7		6.61–6.78 (6.68)	
Seventh coating sheet	7		6.45–6.56 (6.5)	
Eighth coating sheet	7		6.53–6.72 (6.64)	
Roof-central plate	5	4.7–5.3 (5.04)	4.45–4.9 (4.73)	
Roof-cover over the pontoon	5		4.59–4.98 (4.78)	
Roof-pontoon	5		4.45–4.83 (4.68)	

Table 3: Sheet thicknesses measured at different times in different locations of the tank number 3 steel shell

Part of the tank shell	t_{nom} (mm)	Measurements taken in a year (mm)		
		1994	2001	2007
Bottom-middle part	5		4.6–4.9 (4.73)	4.3–4.8 (4.59)
Bottom-peripheral ring	7		6.4–6.7 (6.55)	6.4–6.8 (6.65)
First coating sheet	7		6.2–6.9 (6.57)	
Second coating sheet	6		4.2–5.9 (5.1)	
Third coating sheet	6		5.5–5.7 (5.53)	
Fourth coating sheet	6		5.5–5.8 (5.57)	
Fifth coating sheet	5		4.6–5.0 (4.67)	
Sixth coating sheet	5		4.8–5.0 (4.9)	
Seventh coating sheet	5		3.6–5.2 (4.57)	
Roof-cover over the pontoon	3	2.5–3.5 (3.23)	2.0–3.2 (2.9)	
Roof-pontoon	5		4.4–4.8 (4.7)	

It is easy to notice that the statistical variability of the measured sheet thickness strongly depends on the location of such measurements. Modelling its character with a normal probability distribution seems to be, in the authors' opinion, an oversimplification. It should be additionally emphasized that there is a widespread occurrence of the lack of symmetry of results when estimating the parameters of empirical statistical sample.

6 Identification of the local corrosion progress trends

The collected measurement data, after their prior ordering, enabled insight for each of the tested tanks as to the actual trends of corrosion progress. Individual trends were specified locally, in turn for each subsequent coating sheet of

the considered tank. The obtained results are presented in detail in Figures 13–17. It turned out that the trends observed in individual tanks and locations selected for those tanks were not linear. The corrosion process in subsequent years of use of each of the tested tanks increased initially relatively slowly, but after some time it always accelerated significantly. Such a conclusion does not seem to confirm the accuracy of the assumption verified in these considerations that the application of the formal model describing the corrosion progress as a process linear in time gives sufficiently reliable evaluations to correctly assess the forecasted durability of the fuel tanks.

The corrosion progress in the tank shell sheets can be stopped to some extent by carrying out the renovation of anticorrosion coatings used so far. On the tested tanks, the corrosion progress curve, inventoried by the authors, after locally performed works of this type has been clearly flattened. In the case of the trends shown in Figure 13, it is

Table 4: Sheet thicknesses measured at different times in different locations of the tank number 4 steel shell

Part of the tank shell	t_{nom} (mm)	Measurements taken in a year (mm)		
		1994	2001	2007
Bottom-middle part	5		4.6–4.9 (4.73)	4.5–4.8 (4.71)
Bottom-peripheral ring	7		6.4–6.7 (6.57)	6.4–6.8 (6.59)
First coating sheet	7		5.8–6.7 (6.39)	5.7–6.7 (6.34)
Second coating sheet	6		4.1–5.7 (4.73)	
Third coating sheet	6		5.0–5.6 (5.05)	
Fourth coating sheet	6		5.4–5.9 (5.45)	
Fifth coating sheet	5		4.7–5.0 (4.87)	
Sixth coating sheet	5		4.7–5.0 (4.77)	
Seventh coating sheet	5		4.4–5.0 (4.56)	
Roof-cover over the pontoon	3	2.6–3.5 (3.12)	2.6–3.3 (2.9)	
Roof-pontoon	5		4.0–5.1 (4.73)

Figure 4: A list of thickness measurements for the first coating sheet of tank one (taken in 2006).

Figure 5: A list of thickness measurements for the first coating sheet of tank two (taken in 2007).

Figure 6: A list of thickness measurements for the first coating sheet of tank 4 (taken in 2001).

Figure 7: Location of measuring points presented in a selected segment of the tank shell. The reference of the results obtained from the measurements to the nominal thickness of each tested sheet is also shown here (on the left side). These data are related to tank number 6 which is not considered in detail in this work.

clearly visible that after this type of renovation, the mean value of the coating thickness has increased relatively. Furthermore, the effect of increasing the maximum thickness of the tested sheet was also identified in Figure 16 in relation to tank number 2.

The interpolation method recommended by the authors in this article, based on a very small amount of data, is inherently a very simplified and therefore not very precise analytical approach. However, it was used due to the limitations in the availability of measurement results obtained in the past, which were not always

Figure 8: Histogram of random variation in thickness of corroded sheets obtained for the first coating sheet of the tank number 1. The measurements were taken in 2006. Mean value (estimated from the sample) 10.54 mm, standard deviation 0.22 mm, coefficient of variation 0.021.

Figure 9: Histogram of random variation in thickness of corroded sheets obtained for the second coating sheet of the tank number 1. The measurements were taken in 2006. Mean value (estimated from the sample) 8.42 mm, standard deviation 0.21 mm, coefficient of variation 0.025.

Figure 10: Histogram of random variation in thickness of corroded sheets obtained for the third coating sheet of the tank number 1. The measurements were taken in 2006. Mean value (estimated from the sample) 7.40 mm, standard deviation 0.19 mm, coefficient of variation 0.026.

Figure 11: Histogram of random variation in thickness of corroded sheets obtained for the first coating sheet of the tank number 2. The measurements were taken in 2007. Mean value (estimated from the sample) 10.69 mm, standard deviation 0.19 mm, coefficient of variation 0.018.

Figure 12: Histogram of random variation in thickness of corroded sheets obtained for the first coating sheet of the tank number 4. The measurements were taken in 2001. Mean value (estimated from the sample) 6.39 mm, standard deviation 0.13 mm, coefficient of variation 0.021.

complete with reliability difficult to estimate. In addition, the assumption that the measurements were carried out at different times at exactly the same points of the analyzed sheet seems to be undoubtedly a significant but necessary approximation. The use of smart interpolation techniques [22] could be a more advanced approach in this field, giving more precise estimates of the sought durability.

Figure 13: The progress of corrosion during the use of tank number 1 inventoried by the authors for the first coating sheet (maximum, average, and minimum values are compared here for illustrative purposes).

Figure 14: The progress of corrosion during the use of tank number 1 inventoried by the authors for the second coating sheet (maximum, average, and minimum values are compared here for illustrative purposes).

Figure 15: The progress of corrosion during the use of tank number 1 inventoried by the authors for the third coating sheet (maximum, average, and minimum values are compared here for illustrative purposes).

Figure 16: The progress of corrosion during the use of tank number 2 inventoried by the authors for the first coating sheet (maximum, average, and minimum values are compared here for illustrative purposes).

Figure 17: The progress of corrosion during the use of tank number 4 inventoried by the authors for the first coating sheet (maximum, average, and minimum values are compared here for illustrative purposes).

Table 5: Changes in time of statistical parameters of experimentally measured random thickness of first coating sheet located in the tank number 1

First coating sheet	Measurements taken in a year	
	1995	2006
Mean value (estimated from the sample)	11.10 mm	10.54 mm
Standard deviation	0.14 mm	0.22 mm
Coefficient of variation	0.013	0.021

Table 6: Changes in time of statistical parameters of experimentally measured random thickness of the sheets of floating roof pontoon located in the tank number 3

Floating roof pontoon	Measurements taken in a year	
	1994	2001
Mean value (estimated from the sample)	3.23 mm	2.83 mm
Standard deviation	0.18 mm	0.25 mm
Coefficient of variation	0.056	0.087

Table 7: Changes in time of statistical parameters of experimentally measured random thickness of the sheets of floating roof pontoon located in the tank number 4

Floating roof pontoon	Measurements taken in a year	
	1994	2001
Mean value (estimated from the sample)	3.12 mm	2.89 mm
Standard deviation	0.19 mm	0.19 mm
Coefficient of variation	0.060	0.066

7 Concluding remarks

The results of this analysis, both those which are quantitative and also the qualitative, clearly show that simulating the process of corrosion progress using a conventional linear trend, even if it is appropriately empirically calibrated, can give overly optimistic estimates of the tank shell sheet remaining time to failure and thus may be unsafe due to the forecasted reliability. It has been confirmed here that under real conditions, in spite of the fact that the corrosion progress of tank sheets is initially relatively slow, over time it clearly accelerates. Therefore, it seems that in forecasting the remaining service time to failure for this type of structure, to be sufficiently reliable, one should rely on the power models in which the exponent $\alpha > 1$ [23].

Furthermore, the prediction will be significantly more precise if the theoretical model additionally includes some meteorological characteristics associated with the location of the tested tank, especially those related to atmospheric pollution simulated in its immediate vicinity [24,25]. In the authors' opinion, the corrosion process monotonically growing over time in steel sheets of a fuel tank is above all largely associated with the progressive degradation of the anticorrosive coatings used to protect this tank against such an impact. The type of material stored in a tank is also of key importance for decreasing its corrosion resistance. Sulfur compounds commonly present in typical liquid hydrocarbon fuels seem to be particularly dangerous in this field [26]. Moreover, the experimental research recently carried out by the authors of this work also shows that the corrosive degradation of tank sheets is not only about the progressing loss of their thickness. This loss is always accompanied by a reduction in the strength of the steel from which these sheets are made, as well as an increase in its susceptibility to brittle cracking [1].

The other obvious effect of the progressive corrosion process is also a gradual reduction in the reliability of the tank shell [27]. It is crucial that it is not only a formal reduction associated with the structural system itself. In such process, the parameters describing the random variability of its individual variables also change significantly over time. Such a result is easily observed on the basis of data obtained from the tests reported in this paper and compiled in Tables 5–7. As one can see, in each presented case the mean value of the measured sheet thickness decreases with time, while the standard deviation accompanying this mean value and also the coefficient of variation simultaneously increases.

Conflict of interest: Authors state no conflict of interest.

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