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Implementation of a New Exemplification Informatics Analyses regarding the Industrial Technological Processing of the Domestic Oilducts

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Abstract

In order to implement an exemplifying informatics analysis regarding the industrial technological processing of the domestic crude oil pipelines, it was considered a main pipe line within S.C. CONPET S.A. Ploieşti system, namely, the main pipeline for the imported crude oil with Φ 20 in and 324 km length,, Constanța Sud 2 ARPECHIM Piteşti– Refinery, constructed in 1972.

Starting from the registration of the Evidence File mentioned for this pipeline, for all the damages occurred during the years 2000 and 2008, using successive informatics processings, were emphasized the provoked and unprovoked damages and, according to the occurring data (structured on year/season), according to the location on the pipe line length (structured on segment/sector/district), according on characteristics (structured upon number/orifices areas/corrosion craters, respectively provoked perforations) and according to the effects (structured on crude oil drained quantities/crude oil infested areas/necessary expenses).

This paper represents a first step for the identifying actions of the areas with high defect probability which have to be supervised and if necessary, to be repaired or eventually investigated.

Key words: *oilduct, corrosion, orifice, perforation.*

Introduction

In order to implement an exemplification informatics analyses regarding the industrial technological processing of the domestic pipelines, it was considered as target a main pipeline of S.C. CONPET S.A. system. The whole system is composed of domestic oil transporting pipelines subsystem and imported and off shore transporting pipelines subsystem. The imported crude oil or the crude oil extracted from the Black Sea continental plateau is taken over at Constanța harbour, stored in S.C. Oil Terminal Constanța tanks and then transported in order to be processed to the refineries within the country, through the main pipelines of ∅14 in, ∅20 in, ∅24 in and ∅28 in. For this paper study was selected the imported crude oil main pipeline with ∅20 in and 324 km length, namely Constanța Sud 2 - ARPECHIM Piteşti Refinery main pipeline.

This pipeline was build in 1972, was made of steel tubes, X 60 quality, fabricated according to API Std. 5 LX, (with the following mechanical characteristics $\sigma_c = 422$ N/mm^2 and $\sigma_r = 548$ N/mm^2), procured from abroad, longitudinal welded, with medium length of 10 m, having the ∅ 508 x 6,35 mm dimensions for the operated line and ∅ 508 x 7,92 mm for special situations (railways, roads, rivers, watering ditches, crossings etc.). The pipeline is laid-down at 800 ... 1 200 mm, the designed normal manometer pressure is 57 bar (the current regime pressure is 45 bar). Pipeline insulation was realized with primer (citom), bitumen, fiber glass felt and plastic strip. This pipeline is also equipped with 25 cathodic protection installations – for protection against corrosion – which have every 500 m induced potential taps mounted. Within the system, the main pipeline is fed by the main pumping stations, namely Constanța Sud 2, Bărăganu and Călărești (the intermediary suplementary stations called Mircea Vodă, Dragoş Vodă and Mavrodin are in a preservation process and currently they are not used anymore).

Establishing the Parameters

As primary data, were retained the records from the pipeline Evidence File, referring to all the damages occured among the years 2000 and 2008. The respective damages occured mainly either to the operation activity or because implying some accidental factors. The *exploitation factors* are the deffects produced generally due a long term operation that generates the material yielding by corrosion, errosion or as a result of an unproper processing like not synchronizing the pumping process, on-off operation systems, suddenly closing of valves etc., which, among others, produce supplementary pressure growths resulting pipeline cracking or breaking. The *accidental factors* are the aleatory ones, following to some landslides and falling of ground phenomena in the pipeline proximity, because of floods, strong winds, earthquakes or as a result of unauthorized interventions on pipeline [1].

Considering the nature causes, within this paper the implied damages were grouped in two big categories, namely provoked and unprovoked damages.

Unprovoked damages, define those damages produced after a long exploitation under the corrosion-erosion phenomena. For a further simplifying, the corrosion phenomena are generally treated, without taking into acount the corrosion type, but only the *orifices* or *craters number* caused by the corrosion process and by their dimension (*diameter* or *equivalent diameter*, în case of a great number of orifices).

Provoked damages are the damages produced by artificial causes (not authorized human intervention for stealing oil products). Therefore, as provoked damages we mention installations mounting or attempt of mounting on the pipelines system practicing varied procedures (perforation and welding), in order to steal oil products from an operated or non operated pipeline. As it was considered in the case of the unprovoked damages, it is preferable to characterize the provoked damages also by the number of orifices caused by provoked perforations also by the help of diameter or equivalent diameter, in case of a great number of drilled orifices. For the both cases, the equivalent diameter, when more orifices are present under the circumstance of the same damage, was calculated with the obvious formula:

$$Ø_{ech} = \sqrt{\phi_1^2 + \phi_2^2 + ... + \phi_n^2}\ , \qquad (1)$$

where $\phi_1, \phi_2, ..., \phi_n$ are the diameters of the *n* corresponding orifices.

Corelated with the damages types (unprovoked or provoked), with the number of orifices/craters and with the orifices diameters, were also registered *the data of damages occurrence* (structured according the *seasons*) and damages location (*locality* on the pipeline route where the damage was produced and *the kilometer stone* of the respective locality, measured along the pipeline, in the pumping direction – from Constanța (0 km) till ARPECHIM Piteşti Refinery (324 km)). Also were taken into account:

- *CONPET activity sector* . Constanța South 2 - ARPECHIM Piteşti pipeline of ∅ 20 in, is served by five activity sectors, internaly organized upon geographic criteria, namely Constanța, Bărăganu, Călăreți, Silişte and Poiana Lacului.
- *The pipeline sections*. Depending on the positioning of the pumping stations and on the pipeline ends, the ∅ 20 in, Constanta South 2 – ARPECHIM Piteşti pipeline was divided into three virtual sections, namely: section 1 (Constanta - Bărăganu), section 2 (Bărăganu - Călăreți) and section 3 (Călăreți - ARPECHIM Pitesti).
- *The transit county* The ∅ 20 in pipeline, Constanta South 2 - ARPECHIM Piteşti, crosses the following counties: Constanța, Ialomița, Călăraşi, Ilfov, Dâmbovița and Argeş.
- *The amount of oil drained from a pipe because of a damage*. This is the total quantity of drained oil - due to a damage – until reparation. It is not included the amount of crude oil stolen over time by the help of hand-made equipments found in the case of provocked damages. Also, from the quantities of crude oil drained were not reduced the quantities of recovered oil.
- *Land area infested by the leakage of crude oil, due to the damage*. This is the area of land contaminated with crude oil, due to a damage caused to the pipeline. Land infested with crude oil should be removed and stored in special aranged facilities or should be treated by special procedures and given back to agriculture.
- *Total expenses generated by the effects of the damage occurence and needed for reparation.* Includes the cost of the crude oil amount lost due to the damage, the cost necessary to repair such damage and the cost of giving back to agriculture of the infested land.

Computer Processing. Some Interpretations and Conclusions

In order to highlight the characteristics of the phenomena and processes of corrosion and the delicvence, was developed *the graphic representation* of the data and of the parameters listed in paragraph 2. Such representations contribute to a first and visually intuitive interpretation of the data and often they suggest law itself followed by the studied phenomenon. Graphics representations, for the quantitative characteristics have been designed in relation to a rectangular system of axes, the selection of measure units being arbitrary, depending on the data and parameters represented, so that the graph is proportional to the area represented, in order to facilitate conclusions obtaining. As a way of representing, according to data values and parameters concerned, histograms and representations in bars have been chosen [2].

The number of unprovoked/provocked damages related to the occuring year

During the period 2000 - 2008 (fig. 1), was registered a total number of 172 damages at ∅20 in Constanta South 2 - ARPECHIM Pitesti pipeline, of which 67 were unprovoked damages and 105 were provocked damages. On abscissa axis were represented *the years of unprovoked/provoked damages occured*, and on ordinate was represented *the number of unprovoked/provoked damages occured*, as a way of graphically illustrating, being preferred the histogram. Analyzing the resulting histogram (fig. 1), we can notice the followings:

- In 2000, the number of provoked damages (56) and the ratio of the number of damages provoked and those unprovoked damages (equal to 8) are very high compared with the corresponding figures of the other years. This is explained on one hand, by the fact that delicvence phenomena was much diminished – since 2000 – as pipelines started to be in the custody of guard companies or police and, on the other hand, by legislation strengthening, which discouraged oil thefts attempts from pipelines.

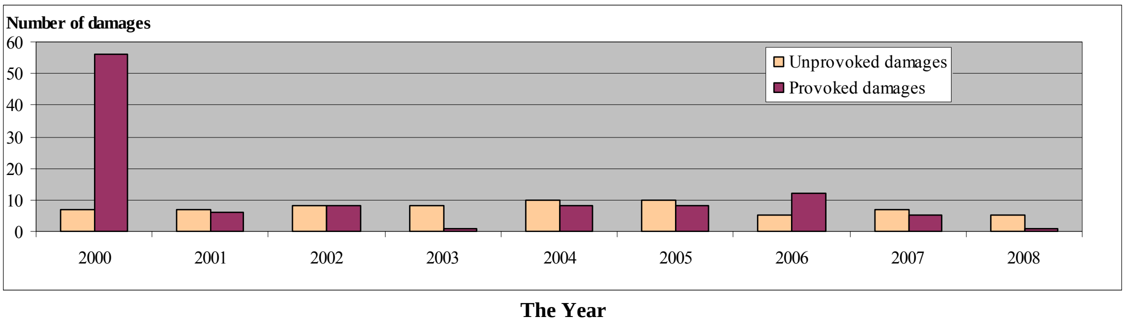


Fig. 1. Damages situation during the years, for 20" pipeline.

- Overall, the number of the provoked damages (105) is greater than the unprovoked damages (67), however, after introducing the guard custody, the situation was reversed: the number of provoked damages (49) became lower than the number of unprovoked damages (60), in 2008, being registered only a single provoked damage.
- The number of unprovoked damages for each year separately, was relatively constant, ranging among 5 and 10, except that, from 2002 to 2005, were developed four corrective maintenance actions (capital repairs) on different sections, with a total length of 3,25 km.

The number of unprovoked/provoked damages, according to the examined section of pipe

In figure 2, on the abscissa axis were represented the three analyzed *sections*, and on the ordinate axis was represented *the number of unprovoked/provoked damages*, the histogram being chosen as a way of graphics illustration. Analyzing the resulting histogram (fig. 2), we can notice the followings:

During the period 2000 - 2008, on section 1 were occurred most damages, unprovoked (29) and also provoked (63), comparing to the other two sections. As percentage, the unprovoked damages – produced on section 1 – represent 43,28 % of the total unprovoked physical damages and the provoked damages from the same section, represent 60 % of the total provoked damages on the whole pipeline.

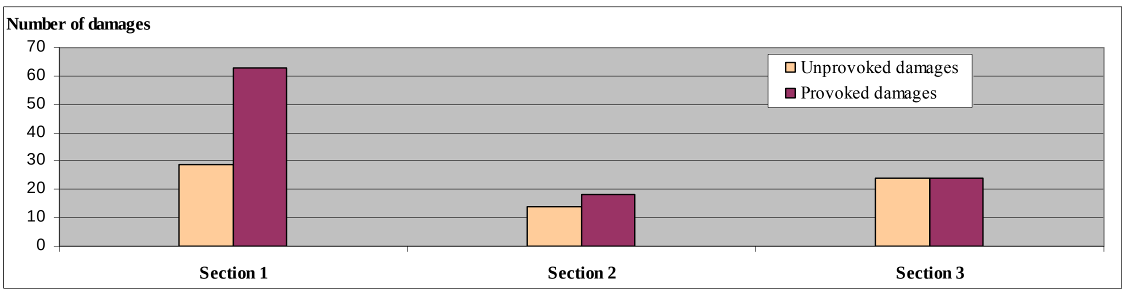


Fig. 2. Damages situation on sections, for 20" pipeline.

- Section 2 was the least affected, in the same period, being recorded 14 unprovoked damages and 18 provoked damages.

Note. Explanation of damage occurence mainly to certain areas crossed by the pipeline, in case of provoked damages, is given by the fact that in those areas, there are large urban agglomerations (prevailing in Constanța, respectively Bucharest), where the probability of existence of qualified personnel is higher.

The number of unprovoked/provoked damages, according to the activity sector of the pipeline operator

In figure 3, on the abscissa axis were represented the five activity *sectors*, and on the ordinate axis was represented *the number of unprovoked/provoked damages*, the histogram being chosen as a way of graphics illustration. Analyzing the resulting histogram (fig. 3), we can notice the followings:

In the period 2000 - 2008, in Constanța sector were occurred the most provoked damages caused (63), compared to the other four sectors, unprovoked damages produced (19) being almost identical in number to those produced in Bărăganu sector (19), respectively Călăreți (18). As percentage, unprovoked damages produced in Constanța sector, represent 28.35 % of the total unprovoked damages, and provoked damages - in the same sector - representing 60 % of all occured damages.

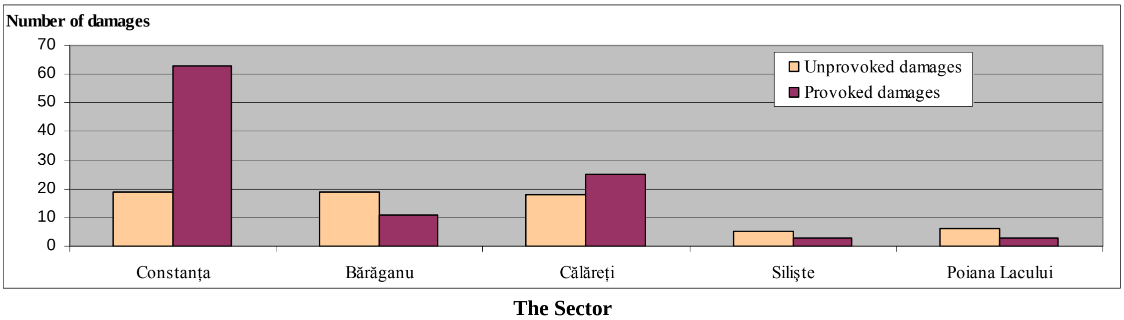


Fig. 3. Damages situation on sectors for the 20" pipeline.

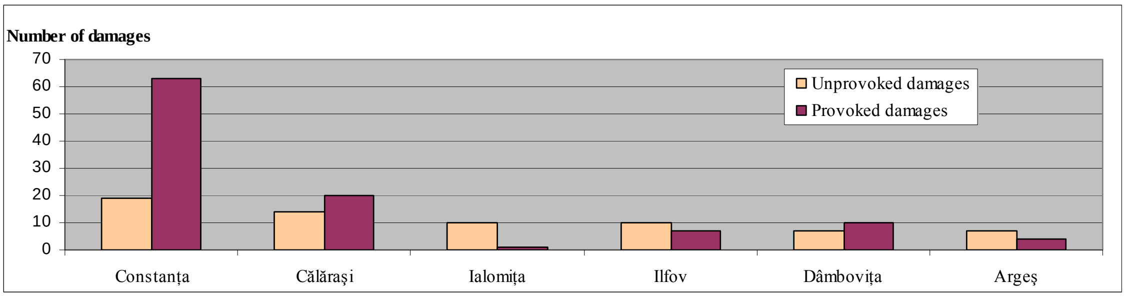
- Silişte sector is the least affected sector, in the same period being registered five unprovoked damages and three provoked damages. Although the sectors of activity Călărețі, Silişte and Poiana Lacului are part of section 3, which has the greatest length, the number of damages caused on sectors Silişte (3) and Poiana Lacului (3) is much smaller.

Note. Such status can be explained by the fact that the sectors of activity at Silişte and Poiana Lacului serve a part of the pipelines of the domestic network and the areas related to these pipelines are much more controlled, because of the near route. In addition, it is maintained the note of the comments in figure 2.

The number of unprovoked/provoked damages related to the crossed county

In figure 4, on the abscissa axis were represented the six *counties* crossed and on ordinate axis was represented *the number of unprovoked/provoked damages*, the histogram being chosen as a way of graphics illustration. Analyzing the resulting histogram (fig. 4), we can notice the followings:

- In the period of 2000 - 2008, in Constanța county occurred the most unprovoked (19) and provoked (63) damages, compared to the other five counties. As a percentage, unprovoked damages occured in Constanța district , represent 28.35 % of the total unprovoked damages and provoked damages in the same county, represent 60 % of all the provoked damages.



The County

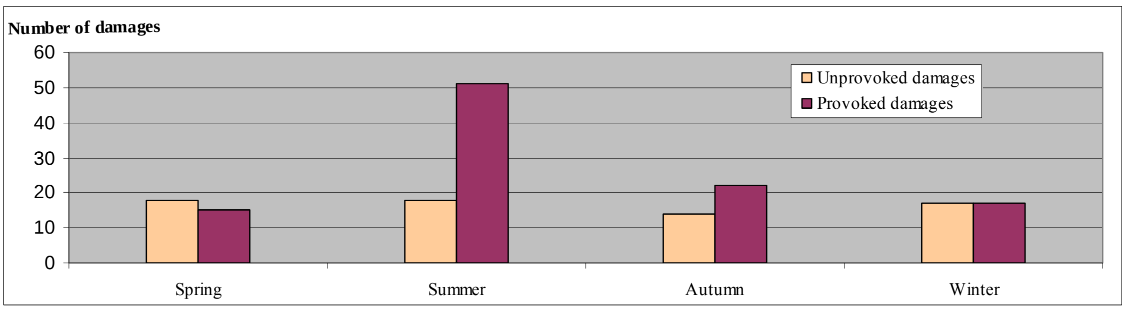
Fig. 4. Damages situation according counties for 20" pipeline.

- Except Constanța county, the number of unprovoked damages is relatively constant, ranging among 7 and 14 for each of the counties Ialomița, Călăraşi, Ilfov, Dâmbovița and Argeş.
- The number of provoked damages in the counties Ialomița (1) and Argeş (4), is very small compared with that of other counties, one explanation being a better organization of security companies, at local county level and another explanation is the lack of the urban agglomeration. In addition, it is maintained the note of comments in figure 2.

The number of unprovoked/provoked damages, depending on the season

In figure 5, on the abscissa axis were represented the four *seasons* and on the ordinate axis was represented *the number of unprovoked/provoked damages*, the histogram being chosen as a way of graphics illustration. Analyzing the resulting histogram (fig. 5), we can notice the followings:

- The most provoked damages occurred during the summer (51), their number representing 48.57 % of the total damages recorded during the years 2000 to 2008. The reason is that during the summer, the specific conditions of season and climate (temperature, precipitation) promote fraudulent interventions. In the other seasons, the number of unprovoked damages (among 14 and 18) and that of provoked damages (among 15 and 22), appear very close as values.



The Season

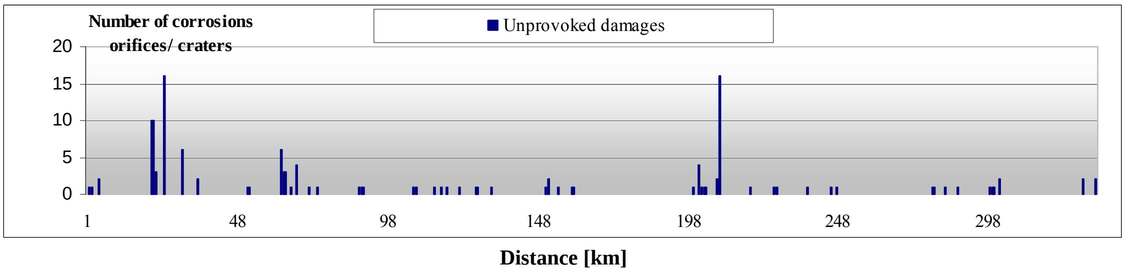
Fig. 5. Damages situation depending on seasons, for 20"pipeline.

- The number of unprovoked damages for each season, in part, is relatively constant, ranging between 14 and 17 for the period 2000 to 2008, which shows that the process of corrosion develops nearly with the same intensity along the whole length of the pipeline, mainly not being dependent on the season.

Number of orifices or craters of corrosion distribution regarding the unprovoked damages and number of produced orifices (perforations) distribution regarding the provoked damages on the whole length of the pipeline

During the period 2000 - 2008 the 67 unprovoked damages were caused by the 115 corrosion orifices or craters and the 105 provocated damages were caused by 165 perforations of the pipeline. In figure 6, on abscissa axes was represented *the length of the pipeline* (in km) and on the ordinate axes was represented *the number of orifices* or *craters of corrosion* regarding the unprovoked damages, respectively, *the number of orifices (perforations)* regarding the provoked damages, the graphic representation in bars being selected as a way of illustration. Upon the analysis of the two representations in bars (fig. 6), we can note the followings:

- The number of corrosion orifices or craters caused by unprovoked damages oscillates between 1 and 15 for each fault in part, except that, for the same section of pipe (the same kilometer stone), within the bars representation, was cumulated the number of orifices at the same number of kilometers of pipeline. We note the fact that:
  - The sections with the most orifices due to corrosion (max. 16), thus, the most affected by corrosion, are those from 20-30, 63-68 and 200-209 km;
  - The section where corrosion occurs uniformly (1 ... 2 orifices) are those from 2-5, 52, 72-75, 89-90, 107-133, 151-160, 219-246, 280-302 and 320-324 km;
  - The longest sections, where were not recorded damages by corrosion, are those of 5-20, 35-52, 52-63, 75-89, 90-107, 133-151, 160-200, 248-280 and 302-320 km.



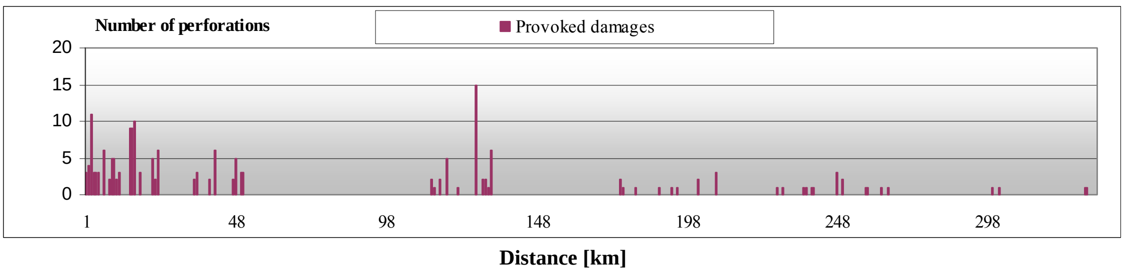


Fig. 6. Distribution of number of orifices regarding the damages occured on the length of 20"pipeline.

- The number of perforations of the provoked damages varies between 1 and 8, for each fault in part, except that, for the same section of pipe (the same kilometer stone), within the bars representation was cumulated the number of orifices at the same number of kilometers of pipeline. Note that:

- The sections with the largest number of perforations caused because of the provoked damages (max. 15), are those from 1-22, 34-50 and 113-133 km, Constanța being the most affected area;
- Sections where the number of perforations caused because of the provoked damages is approximately constant (1-3 orifices) are those of 176-208, 228-265, 300-302 and 320 km;
- The longest sections, where were not registered provoked damages, are those from 22-34, 50-113, 133-176, 208-228, 265-300 and 302-320 km. Notes of comments in figures 2 and 3 are maintained.

Corrosion orifices or craters areas values distribution caused by unprovoked damages and produced orifices (perforations) areas values distribution caused by provoked damages on the whole length of the pipeline

During the period 2000 - 2008 the 67 unprovoked damages were caused by the 115 orifices or corrosion craters with diameters (equivalent) of 1 ... 30 mm and the 105 provoked damages were due to 165 perforations of the pipeline with diameters (equivalent) of 4 ... 72 mm. In figure 7, on the abscissa axes was represented *the pipeline length* (km) and on the ordinate axes were represented *the values of the corrosion orifices areas or craters* due to unprovoked damages, respectively *the values of the orifices areas (perforations)* caused by provoked damages (in cm^2); The graphical representation in bars was chosen as a way of viewing. Upon the analysis of the two representations in bars (fig. 7), we can note the followings:

- The values of the corrosion orifices or craters areas caused by unprovoked damages are situated on range from 0,00785 cm^2 to 7,065 cm^2, for each failure in part, except that, for the same section of pipe (the same kilometer stone), within the representation with bars were cumulated the areas values at the same number of kilometers of pipeline. Note that:
  - The sections with the highest values of areas of corrosion orifices or craters (maximum value of 7,065 cm^2), thus the most affected by corrosion, are those of 5, 63 and 200 km;

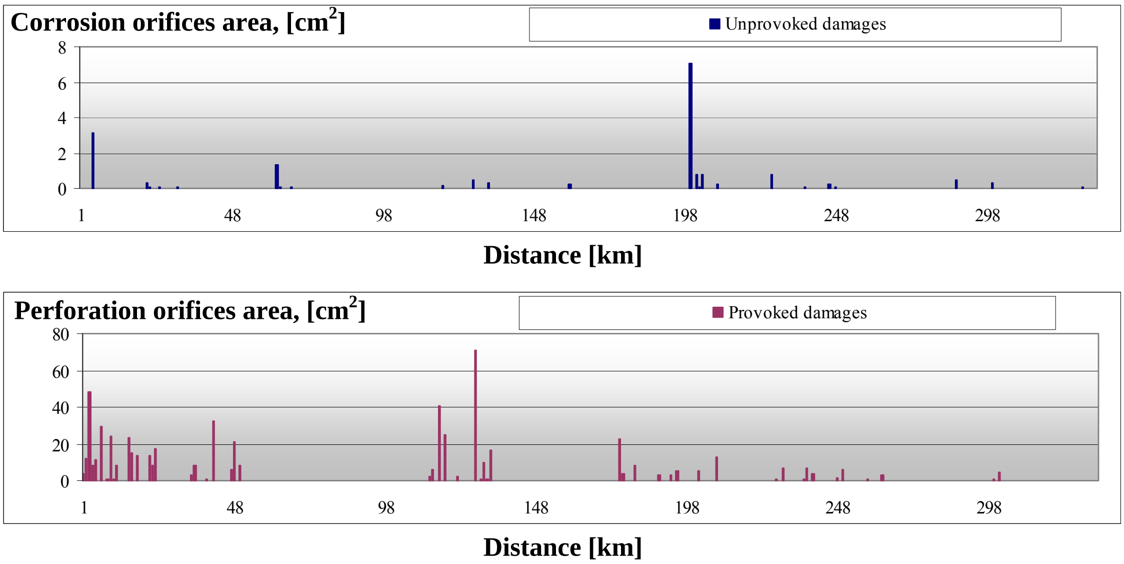


Fig. 7. Distribution of orifices areas caused by damages along the length of the 20"pipeline.

- Sections with relatively small areas of corrosion orifices or craters (less than 1 cm^2) values are those at 2-3, 20-35, 64-68, 89-90, 128-133, 151-155, 202 -209, 227, 246-248, 288, 299-300 and 324 km;
- The longest sections, where were not recorded corrosion damages, are those mentioned in the comments at figure 6, namely those from 5-20, 35-52, 52-63, 75-89, 90-107, 133--151, 160-200, 248-280 and 302-320 km

o Perforation orifices areas values due to provoked damages range from 0,1256 cm^2 to 40,6944 cm^2, for each fault in part, except that, for the same section of pipe (the same kilometer stone), within the representation with bars, were cumulated the values of the orifices areas at the same number of kilometers of the pipeline. Note that:

- The section with the highest values of the perforation areas caused by provoked damages (max. 40,6944 cm^2), thus the most affected by corrosion, are those from 2-22, 41-50, 113-133 and 166-177 km;
- Sections with relatively small areas of corrosion orifices or craters (less than 20 cm^2) are distributed among the ranges listed above, for the sections with the highest values and also in those at 181-208 km, 228-265 km and 300-302 km;
- The longest sections, where were not registered provoked damages are those mentioned in the commentary at figure 6, namely those from 22-34, 50-113, 133-176, 208-228, 265-300 and 302-320 km. Notes of comments in figures 2 and 3 are maintained.

Distribution of crude oil quantities lost by leakage, due to unprovoked/ provoked damages until reparation, for the whole length of pipeline

Between the years 2000 - 2008, the 67 unprovoked damages caused – in 43 cases – leakages and loss of flow in total quantity of 193,699 t of crude oil, for the other 24 cases the losses were minor (no longer registered under 0,030 t = 30 kg each). The 105 provoked damages caused by 165 penetrations of pipe, determined – in 81 cases – leakage and loss of total quantities of crude oil of 21 729,157 t, in the other 24 cases losses were minor (no longer registered under 0.200 t = 200 kg each). In figure 8, on the abscissa axes was represented *the pipeline length* (km) and on the ordinate axes were represented *the quantities of crude oil lost by leakage* due to unprovoked/provoked damages until their remedy (in t); as way of viewing, the graphic representation in bars being chosen. Upon the analysis of the two representations in bars (fig. 8), we can note the followings:

o The quantities of crude oil lost by leakage due to unprovoked damages until their remedy, for the whole length of pipe, range between 0,034 t and 45,092 t, for each fault in part, except that, for the same section of pipe (the same kilometer stone) within the representation with bars, were accumulated quantities of crude oil leakage at the same number of kilometers of pipeline. Note that:

- The sections with the largest quantities of crude oil, lost by leakage due to pipeline corrosion (maximum of 45.092 t), are those of km 20, km 63, km 133 and km 227;
- Sections with intermediate values (of 1-10 t) of crude oil quantities lost by leakage due to pipeline corrosion, are those from km 5, 20, 118, 128, 160, 202-204, 209, 246, 288, 300 and 324;
- Sections with low values (below 1 t) where the crude oil quantities lost by leakage due to corrosion of the pipeline are in number of 23, totaling 11.492 t.

Note. There is not a direct correlation between the orifice size and the quantity of crude oil lost by leakage, as more factors are involved: the pipeline pressure intensity, the moment of the damage observing, reaction time to stop pumping and remedy the damage, geo-tectonics land, soil composition etc.

- o Quantities of crude oil lost by leakage due to provoked damages until their remedy for the entire length of the pipeline, range from 0,203 t and 2 547,667 t for each fault in part, except that, for the same section of pipe (the same kilometer stone), within the representation with bars (fig. 8) were accumulated quantities of crude oil leakage at the same number of kilometers of pipeline. Note that:
  - Sections with the largest quantities of oil, lost by leakage due to perforation of the pipe (max. 2 559,793 t), are those from 10, 16, 22, 41, 47, 114, 118, 128, 176, 195 and 202 km;

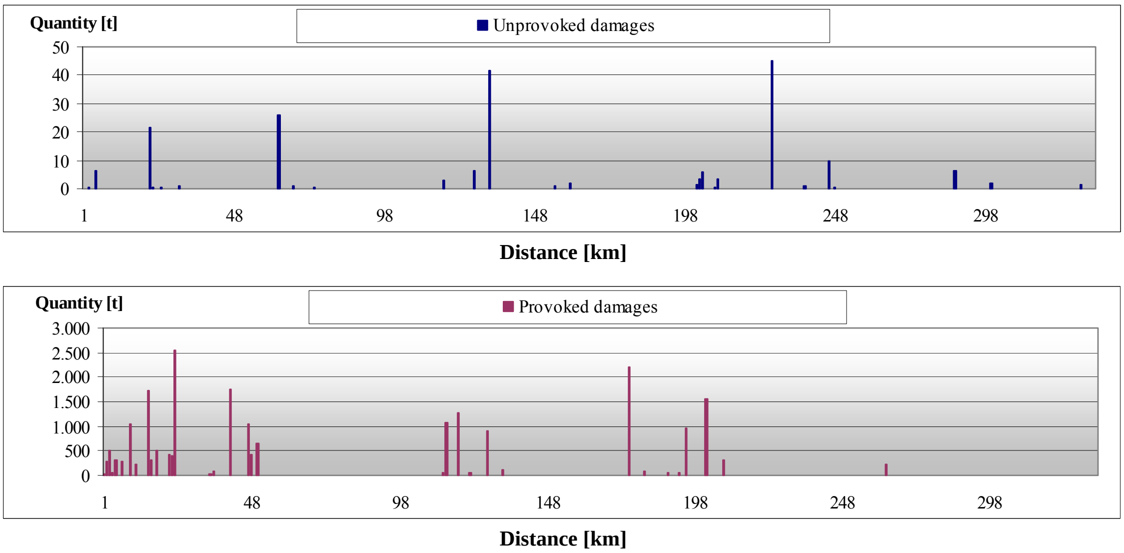


Fig. 8. Leakage of crude oil, due to damages, on the 20"pipeline length.

  - Sections with intermediate values (of 100-500 t) of quantities of crude oil lost by leakage due to the pipeline perforation, are concentrated – primarily – at 1-22, 34-50, 113-133, 176-208 and 263 km;
  - Sections with low quantities (below 100 t) of crude oil lost by leakage due to perforation of the pipeline are 44, totaling 1 417,067 t of lost crude oil. Notes of comments in figures 2, 3 and 8 are maintained.

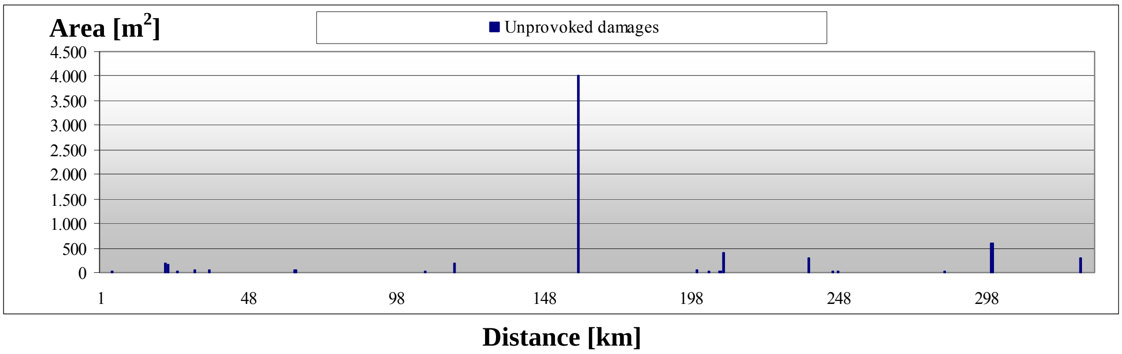
Note that during the years 2000-2008, the total quantity of crude oil, lost because of leakage caused by provoked damages (21 729,157 t) which is about 112 times greater than the sum of the crude oil quantities lost by oil leakage due to unprovoked damages (193,699 t) and the maximum quantity recorded for a single provoked damage (2 559,793 t), is nearly 57 times the maximum amount of damage recorded for an unprovoked damage (45,092 t).

Distribution of surface areas of land affected, because of the quantities of crude oil lost by leakage due to unprovoked/provoked damages on the entire length of the pipeline

Between the years 2000 - 2008, the 67 unprovoked damages determined in – 41 cases -– affecting of some areas of land, with a total area of 6 652 m^2, because of the quantities of crude oil lost by leakage, in the other 26 cases the areas affected are less than 1 m^2 and have not been registered. The 105 provoked damages caused by 165 penetrations of pipeline, determined – in 35 cases – affecting of some areas of land with a total area of 240 186 m^2, because of the quantities of crude oil lost by leakage, in the other 70 cases, the areas affected are less than 2 m^2

and have not been registered any more. In figure 9, on the the abscissa axes was represented *the pipeline length* (km) and on the ordinate axes were represented *the areas of land affected* (infested, infected), because of the quantities of crude oil lost by leakage due to unprovoked damages, respectively provoked ones (in m^2) as a way of viewing being chosen the graphic representation with bars. Upon the analysis of the two representations in bars (fig. 9), resulted the followings:

- Affected areas of land due to the quantities of crude oil lost by leakage due to unprovoked damages, for the entire length of the pipeline vary between 1 m^2 and 4 000 m^2 for each fault in part, except that, for the same section of the pipeline (same kilometer stone) within the representation with bars were cumulated the land affected areas due to quantities of oil lost by leakage, at the same number of kilometers of pipeline. Note that:
    - Sections with the highest values of areas of land affected due to quantities of crude oil lost by leakage due to pipeline corrosion (max. 4 000 m^2), are those from 160 and 300 km;
    - Sections with intermediate values (100 ... 400 m^2) of surface land areas affected because of the quantities of crude oil lost by leakage due to pipeline corrosion, are those from 20, 21, 118, 209, 238 and 324 km;
    - Sections with low values (below 100 m^2) of surface land areas affected because of the quantities of crude oil lost by leakage due to corrosion of the pipeline are 33, totaling 502 m^2.



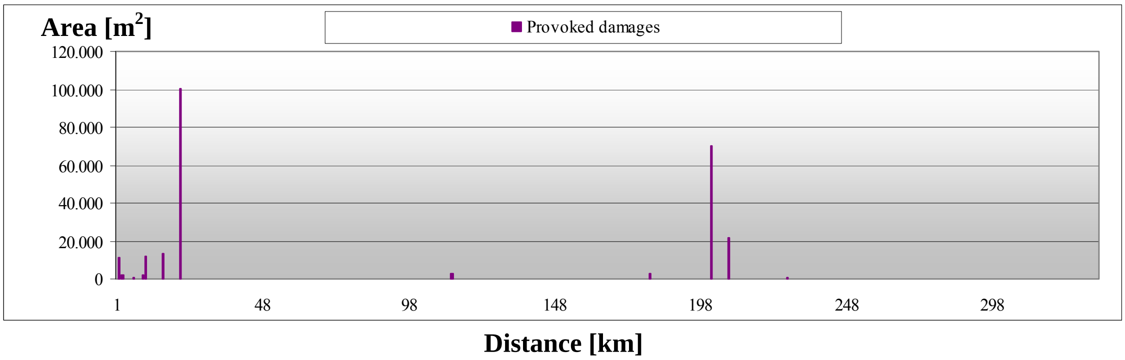


Fig. 9. Distribution of land surfaces infested due to damages on the 20" pipeline length.

Note. There is not a direct correlation between the orifice size, the quantity of crude oil lost by leakage and the surface area of land affected due to quantities of oil lost by leakage, as more factors are involved: the pipeline pressure intensity, the moment of the damage observing, reaction time to stop pumping and remedy the damage, geo-tectonics land, soil composition and permeability, the way of scattering the product, environment temperature, the existing vegetation on the ground etc.

- Areas of land affected because of the quantities of crude oil lost by leakage due to provoked damages, on the whole length of pipeline, ranging between 2 m^2 and 100 000 m^2 for each fault in part, except that, for the same section of the pipeline (same kilometer stone) within the representation with bars, were cumulated the areas of land affected due to crude oil quantities lost by leakage, at the same number of kilometers of the pipeline. Note that:
  - The sections with the highest values of surface areas of land affected due to quantities of crude oil lost by leakage caused by the pipeline perforation (max. 100 300 m^2), are those from 20, 202 and 208 km;
  - Sections with intermediate values (of 10 000 ... 15 000 m^2) of land surface areas affected due to quantities of crude oil lost by leakage caused by perforation of the pipeline, are those from 2, 11 and 17 km;
  - Sections with low values (less than 2 500 m^2) of land surface areas affected due to quantities of oil lost by leakage caused by the pipeline perforation are 29, totaling 16 186 m^2. The note of figure 9 comment is maintained.

Note that during the years 2000-2008, the total area of land affected due to quantities of crude oil lost by leakage caused by provoked damages (240 186 m^2), is about 36 times higher than the total surface area of land affected due to the quantities of crude oil lost by leakage caused by unprovoked damages (6 652 m^2) and the maximum value recorded in the event of a provoked damage (100 000 m^2), is 25 times higher than the maximum value recorded in the event of an unprovoked damage (4 000 m^2).

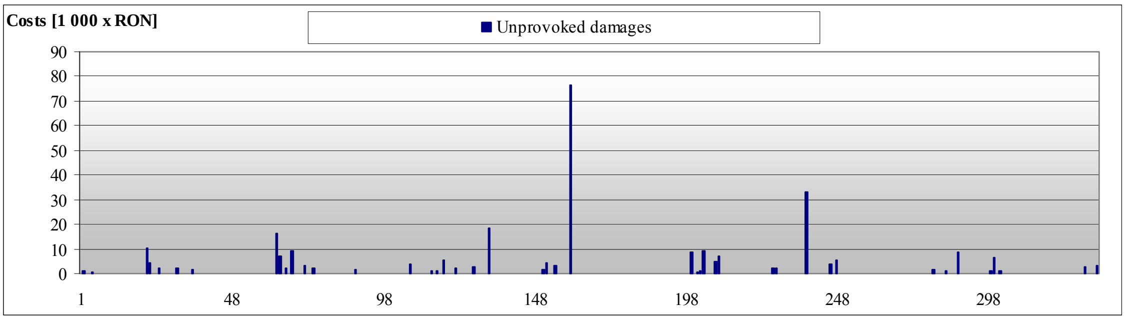
Necessary costs distribution for remedy and removal of the unprovoked/ provoked damages effect for the whole length of pipeline

Between the years 2000 - 2008, the necesary costs of remediation and the removal of the effect for the 67 unprovoked damages, amounted up to 290 457,81 RON and for those 105 provoked damages amounted up to 10 034 437,79 RON. In figure 10, on the abscissa axes was represented *the pipeline length* (in km) and on ordinate axes were represented *the necessary costs for remediation and removal of unprovoked damage effect, respectivelly provoked* (in thousands RON), as a way of viewing being chosen the graphic representation with bars. Upon the analysis of the two representations with bars (fig. 10), resulted the followings:

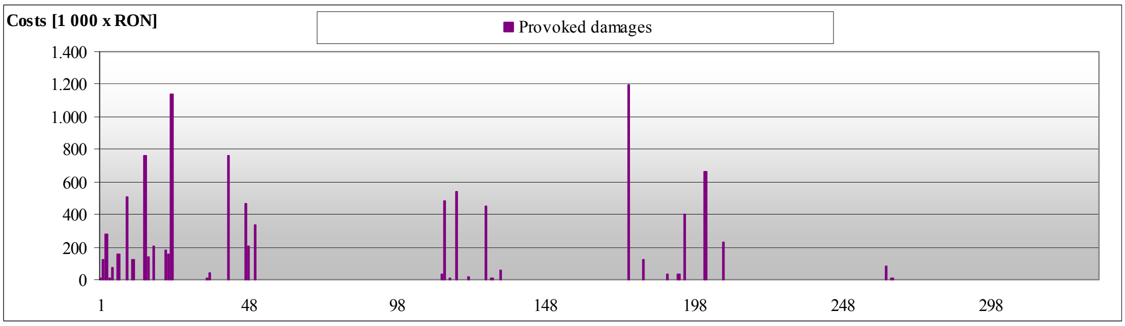
- The necessary costs for remediation and removal of the unprovoked damages effect, for the whole length of pipeline, range between 30,21 RON and 76 464,66 RON for each fault in part, except that, for the same section of pipeline (the same kilometer stone) within the bars representation were cumulated the necessary costs for remedy and remove of the unprovoked damages effect, at the same number of kilometers of the pipeline. Note that:
  - The section with the highest values of the cost necessary to remedy and remove the effect of damages caused due to pipeline corrosion (max. 76 464,66 RON), are those at 20, 63, 133, 160 and 238 km, the total sum of these five sections representing 154 684,43 RON, which is 53.25 % of the full amount of costs;
  - All the other sections have values below 10 000 RON for the costs to remedy and remove the effect of each damage in part because of pipeline corrosion, the total amount reaching the value of 135 773,38. RON.

Note. The analysis of data shows that there is a direct correlation between the amount of crude oil lost by leakage, the area of land affected due to quantities of crude oil lost by leakage and the costs necessary to remedy and remove the effect of the unprovoked damage, but can also occur the following factors: the pipeline pressure intensity, the moment of the damage observing, reaction time to stop pumping and remedy the damage, geo-tectonics land, soil composition and permeability, the way of scattering the product, environment temperature, the existing vegetation on the ground, the complexity of reparation, accessibility to the damage area etc.

- Necessary costs for remediation and removal of provoked damages effect on the entire length of pipeline, range between 86,45 RON and 1 194 498,08 RON for each fault in part, except that, for the same section of pipe (the same kilometer stone), within the bars representation were cumulated the costs necessary to remedy and remove the effect of provoked damages at the same number of kilometers of pipeline. Note that:
- The sections with the highest values of the cost necessary to remedy and remove the effect of damages caused due to perforation of the pipeline (max. 1 194 498,08 RON, are those from 3, 10, 16, 22, 41, 47, 50, 114, 118, 128, 176, 195, 202 and 208 km, the total amount of those 14 sections representing 6 980 550,96 lei, meaning 69.56 % of the full amount;



Distance [km]



Distance [km]

Fig. 10. Necessary costs distribution for damage remediation for the20" pipeline length.

- All the other sections, focused – primarily – at 1-22, 34-35, 48, 113-133, 177-208 and 263 km, have values below 200 000 RON of the cost to remedy and remove every damage effect produced due to perforation of the pipeline, the total amount reaching 3 053 886,83 RON. The notes in fig.2 and 10 comments are maintained.

Note that during the years 2000-2008, total expenditures required to remedy and remove the effects of provoked damages (10 034 437,.79 RON) is about 35 times higher than the expenditures required to remedy and remove the effect of unprovoked damages (290 457,81 RON), and the maximum value recorded in the event of a provoked damage (1 194 498,08 RON), is nearly 16 times higher than the maximum recorded in the event of an unprovoked damage (76 464.66 RON).

Taking into account the age of the pipeline (38 years) in 2008 was performed an in-line pipeline inspection using a intelligent godevil (ROSEN company - Netherlands), thus resulting the most affected areas proposed for maintenance (replacement of pipeline sections). It should be noted that at a cursory examination, the sections with the more orifices or with the highest values of the orifices areas or craters due to corrosion or perforation represented in figures 6 and 7 (prepared with 1 km precision), were found applying the in-line inspection method with intelligent godevil, this time being exactly positioned with high precision.

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Implementarea unei analize informatice exemplificatoare privind procesarea tehnologică industrială a oleoductelor indigene

Rezumat

Pentru implementarea unei analize informatice exemplificatoare privind procesarea tehnologică industrială a conductelor indigene, s-a considerat o conductă magistrală din sistemul S.C. CONPET S.A. Ploieşti, şi anume, conducta magistrală pentru ţiţeiul importat Φ 20 in, în lungime de 324 km, Constanţa Sud 2 – Rafinăria ARPECHIM Piteşti, construită în anul 1972.
Pornind de la înregistrările din Fişa de evidenţă ale acestei conducte, pentru toate avariile survenite în intervalul cuprins între anii 2000 şi 2008, prin prelucrări informatice succesive, au fost evidenţiate avariile neprovocate şi provocate, funcţie de datele de producere (structurate pe ani/anotimp), funcţie de localizarea pe lungimea conductei (structurate pe tronson/sector/judeţ), funcţie de caracteristici (structurate pe număr/arii de orificii/cratere din coroziune, respectiv perforări provocate) şi funcţie de efecte (structurate pe cantităţi de ţiţei scurse/suprafeţe de teren infestate/cheltuieli necesare).
Lucrarea reprezintă un prim pas în acţiunile de identificare a zonelor cu probabilitate ridicată de defectare, ce vor trebui monitorizate şi, dacă se impune, reparate sau eventual investigate.