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RESEARCH AND DEVELOPMENT OF ENVIRONMENTALLY AWARE TECHNOLOGIES FOR FIGHTING THE FIRE OF STORAGE TANKS

résumé, written by the author of the (PhD) dissertation,
and its recension from official opponents

Scientific Tutor:
Dr. habil Oszkár Cziva PhD col.

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DEFINITION OF THE SCIENTIFIC PROBLEM

Environmentally aware approach is inevitable to be introduced in extinguishing fire. Large storage tank fires and their extinguishing entail enormous environmental harm.

The **currently-used traditional tactical instructions** of extinguishing fire in these cases can not cope with the technical difficulties of these large sizes and do not fit to the principles of environmentally aware approach.

The **problem** cannot be **solved** by increasing the quantity of technical equipments used in traditional way of extinguishing fire.

How to fight fire of storage tank fires **under extreme circumstances** (lacking water and energy supply and human resources) is still a question unanswered.

SCIENTIFIC OBJECTIVES

My scientific objectives include the following points:

1. to **create** the theoretical **principles** of a new environmental friendly technology by examining the environmental impacts caused by tank fires and the traditional strategies of extinguishing them.
2. to **elaborate** on a **technical apparatus** of the new technology that enables us an effective, environmentally safe fire fighting technology of storage tank fires under extreme conditions (lacking water or energy supply and human resources, plus extremely low ambient temperature).
3. to **prove** the practical adaptability of the solution in an experimental way.
4. to **make a proposal** to introduce new extinguishing regulations to be used in practice appropriate to extinguishing fire of storage tanks of any size and construction.

RESEARCH METHODS

As the **main method** of my research work I collected, processed, systemized and analyzed all the accessible knowledge on the subject.

My **sources** were from The National Technical Information Centre, the library of Miklós Zrínyi National Defence University, my library, the patent collection of the Hungarian Patent Office, Flórián exPress and Védelem of the national journals, International Hydrocarbon, Fire and Rescue, Fire International, Industrial Fire Journal, Industrial Fire Protection of the international journals and the Internet.

I **consulted** foreign scientists dealing with the topic, I participated in a number of conferences, I checked the reports of LASTFIRE and FOAMSPEX research, and I also delivered lectures.

I carried out **experiments**, measurements of cold foam spreading and testing fire extinguishing, and built reference apparatus to prove the adaptability of the technology I created.

SCIENTIFIC RESEARCH

First in my dissertation I will examine the causes, the features, and all the phenomena of extinguishing fire of different types of tank constructions and their environmental impacts on soil and water. I will evaluate the different environmental impacts.

Furthermore, I discuss the theoretical and practical odds of reducing environmental pollution. I examine the proportion of air pollution to preparation and extinguishing time. I observe the connection between the extent of soil pollution and the chosen technical solution of foam introduction, the applied extinguishing method.

Finally, based on the scientific research of the chapter, I introduce the details of my new environmental friendly technology of extinguishing storage tank fires. I prove its technical adaptability. I state to have chosen the proper way to reach my research objectives. I present a proposal to introduce new dynamic tactical instructions of extinguishing tank fires for disaster recovery. I discuss a practical design procedure for designers of fire protecting apparatus. I also introduce the technical solution of foam introduction and foam supply.

CONCLUSIONS

In my essay all the scientific problems were solved and my objectives were realized.

My findings were:

1. The air pollution caused by tank fires is in proportion to burning time, tank size and the physical-chemical features of the stored material. We are given the tank size and the quality of the material, the way of reducing air pollution is to reduce burning time. This can be divided into two phases, the preparation and the extinguishing time.

2. The length of the preparation time depends on the chosen protecting strategy (extinguishing by fixed, semi-fixed and mobile extinguishing equipment). It is quite obvious that preparation time is the shortest in case of operating with fixed extinguishing installations.

3. The extinguishing time depends on the extinguishing technology, namely the foam application intensity. The most favourable extinguishing strategies regarding extinguishing time are the ones from intensity range of superintensive foam flooding.

4. The foam closing time (the extinguishing time) is in inverse ratio to the penetration velocity, which is the velocity the foam spreads on the liquid surface. The penetration velocity can be influenced by the foam solution intensity and the geometrical relations of foam introduction. Concerning these facts, the most adequate foam introduction is the curtain-like manner flowing down the inside surface of the shell of the tank, and spreading horizontally due to the penetration velocity increasing to the centre of the liquid surface.

5. Extinguishing fire in case of large storage tanks the value of penetration velocity should be increased in order to prevent foam destruction. The penetration velocity in case of introducing foam in a curtain-like manner can be measured by hydrostatical pressure at the bottom of the foam mass accumulated at the meeting point of the liquid surface and the tank shell, it can also be triggered by increasing the foam volume in proportion to the length unit of the tank perimeter.

6. The foam material whenever used in extinguishing is not environmental friendly. To avoid polluting soil and underground water total foam volume should be decreased and we should adapt a method involving no aiming loss. Based on the outcome of my research, I suggest the curtain-like manner is the most favorable method in order to avoid aiming loss.

7. Foam release caused by a false alarm, typical of automatically operating apparatus, should be avoided as well. I proved in practice by the help of a real life industrial extinguishing equipment that the problem can be solved with a system having safely switching actuator.

8. I proved by industrial references that the automatic extinguishing systems operating with instant foam can provide the protection of tanks storing hydrocarbon under extreme conditions (lacking water, energy supply and human resources). Tanks provided by individual protection are defended from sabotage in a higher level than the ones provided by traditional protection since there is no common critical infrastructure of the members of the set of tanks.

NEW SCIENTIFIC RESULTS, PROPOSITIONS

1 I **created** and introduced the foam effectiveness factor in order to facilitate the contrasting survey, the curve of penetration velocity and foam profile, and I also **defined** the geometrical coherence of foam introduction. I **discovered** the physical explanation for a well-known phenomenon namely the wall-effect, which makes extinguishing storage tank fires more difficult, and explained the anomalies experienced during the process.

2. I **developed** a new extinguishing technology and apparatus of storage tank fires based on the updated environmental safety regulations. I **proved** that adapting these equipment of extinguishing is perfect to reduce air, soil and underground water pollution caused by tank fires and I proposed to introduce **dynamic tactical instructions**.

3. I developed a technical proposal to solve the problems of fighting tank fires in sites lacking water supply and a fire brigade, and I evolved an extinguishing control system operating with multi-detector, without external auxiliary energy supply.

PROPOSALS FOR FURTHER RESEARCH WORK

I intend to continue the research work to elaborate on the new technology in the following way:

- conducting international qualifications and exploiting the experiences attained

- in order to define the most economical foam blanket thickness testing foam spreading velocity—possibly in cooperation with international organizations

- developing the equipment of foam introduction and the installation subsequently to an operating tank with cold technology

- in order to define the impacts and the odds from breakdown caused by faulty, partial operation of the continuous linear nozzle.

RECOMMENDATIONS

1.Firstly, I recommend the theoretical and practical results of my research to the attention of the legislators issuing tactical instructions of industrial fire fighting.

2.The outlined results of this scientific research can be exploited in refineries, oil-storage tank farms, power stations, chemical plants while obeying protection instructions.

3. I also recommend my essay as an educational material to introduce new extinguishing technologies of storage tank fires for learners of fire protection and security technology.

4.Construction engineers designing built-in automatic and autonomous extinguishing systems operating under extreme conditions can also take advantage of this essay.

5.Companies operating with environmentally aware management can also adopt the environmental friendly extinguishing technology discussed here. This is the most efficient strategy to extinguish the rim seal fire of large storage tanks with floating roof adapting either the fixed or the mobile foam supply.

LIST OF MY PUBLICATIONS

Manuscript

Fire extinguishing in flammable liquid storage tanks by superintensive foam flooding. 2002, pp. 0-99. (ready to be published)

Other publications

Scientific publications appeared in journals

Szőcs, István: Extinguishing of flammable liquid storage tanks *Tűzvédelem* No. 1999/8. pp 32-35.

Szöcs, István: Foam for preventing fire. Védelem, 2001/2, pp. 49.

Szőcs, István: Extinguishing tank fire by instant foam. *Védelem*, 1999/4. pp 13-15.

Szőcs, István: The influence of the wall-effect ont he efficiency of extinguishing. Védelem, 2002/3, pp. 38-40.

Szőcs, István: Extinguishing storage tank fires. Védelem, 2002/4, pp. 39-42.

Szőcs István: Procedure and apparatus for extinguishing tank fire. Hungarian patent application: P9800877. April 15, 1998.

Szőcs, István: Method and high capacity apparatus for fire fighting of flammable liquid storage tanks. PCT patent application: PCT 990027, April 15, 1999

National conference issues, lectures:

Szőcs, István: Results achieved by IFEX Tűzvédelmi Kft. in extinguishing fire of vertical cylindrical tanks containing flammable fluids by foam. National Conference on Fire Prevention, Gyula, Hungary, 1998

Szőcs, István: Fire extinguishing of flammable liquid storage tanks by Superintensive Foam Flooding. Conference of European Refineries. Százhalombatta, Hungary, 2000.

Szőcs, István: Impact of the foam introduction geometry on the extinguishing efficiency. National Fire Prevention Conference, Debrecen, Hungary, 2000.

Scientific publication appeared in non-edited journals:

Szőcs, István: Extinguishing flammable liquid storage tanks *Tűzvédelem* No. 1999/8. pp 32-35.

Szőcs, István: A new way of adapting instant foam. Florian Press, 1999/10. pp. 9-11.

Szőcs, István The influence of foam introduction geometry to the efficiency of extinguishing fires. Florian Press, 2000/5., pp. 10-17.

Szőcs, István: Semi-stable tank fire extinguishing apparatus by applying the persistent linear nozzle. 2001/1, p.5.

Szőcs, István: Instant foam. Florian Press, 2001/1., p. 43.

Koczka S., Szenczi R., Szőcs I.: control alternatives extinguishing tanks and store fires. Florian Press,10. évfolyam,10 szám, 2001 október, pp. 728-729.

Szőcs, István: Comparative testing of tank fire extinguishing procedures. Florian Press, 2003/6., pp. 376-381.

My inventions

My inventions only related to tank fires:

No	Date	Description	Country	List No.	Status
1.	1990. 05. 28.	Foam compound	Hungary	213496	Granted
2.	1998. 04. 15.	Method and high capacity apparatus for producing fire fighting foam and foam expanding spreading device	Hungary	P98008-77	in progress

3.	1999. 04. 15.	same as2.	PCT	PCT/HU 99/00027	in progress
4.	1999. 04. 15.	same as2.	EP	99 915 962.7	in progress
5.	1999. 04. 15.	same as2.	Norway	20005175	in progress
6.	1999. 04. 15.	same as2.	USA	eljárás alatt	in progress
7.	1999. 04. 15.	same as2.	Poland	189.566	Granted
8.	1999. 04. 15.	same as2.	Croatia	P200000779A	in progress
9.	1999. 04. 15.	same as2.	South-Africa	2000/6454	Granted
10.	1999. 04. 15.	mint 3.	Austra-lia	762.141	Granted
11.	1999. 04. 15.	same as2.	Canada	2,328,972	in progress
12.	1999. 04. 15.	same as2.	India	2000/00651	in progress
13.	1999. 04. 15.	same as2.	Slovakia	PV-1552-2000	in progress
14.	1999. 04. 15.	same as2.	Hong Kong	01105533.2	in progress
15.	2000. 05. 02.	Semi fixed fire extinguishing installation for flammable liquid, mainly for hydrocarbon storage tanks	Hungary	223 507	Granted
16.	2002. 04. 17.	Automatic foam fire fighting equipment especially used as fixed installation equipment for fire fighting of large hydrocarbon storage tanks	Hungary	P0201260	in progress
17.	2002. 12. 30.	same as 16.	PCT	PCT/HU 02/00177	in progress
18.	2002. 12. 30.	same as 16.	EP	02793261.5-2318	in progress
19.	2002. 12. 30.	same as 16.	Eurasian Patent	006175	Granted
20.	2003. 04. 16.	same as 16.	Nigéria	RP. 15518	Granted
21.	2002. 12. 30.	same as 16.	UAE	406/200	in

				4	progress
22.	2002. 12. 30.	same as 16.	China	0282899 6.X	in progress
23.	2002. 12. 30.	same as 16.	Japan	0410050 FPC	in progress
24.	2002. 12. 30.	same as 16.	Ukraina	2004110 9438	in progress

RESUME

Personal details:

Name:	István, Szőts
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Mother's name:	Ilona, Huszti
Workplace:	IFEX Engineering Office Ltd.
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Educational background

2005-	Miklós Zrínyi National Defence University, Phd Institution of Military Science
1966-1969:	Veszprém Chemical University, Heavy Chemical Engineering Department
1962-1965:	Kazincbarcika Chemical Engineering College, Measuring and Regulating Technology Department
1957-1961	Lajos Petrik Chemical Technical School

Major courses:

2004:	qualified as an environmental managing auditor (TÜV Rheinland)
1996:	qualified as designer of fixed installations (BM TOP)
1991:	qualified as a leading pyrotechnician (VRF)

Language examinations:

2004:	Intermediate Level of State Examination of English language
2005:	Basic Level of State Examination of German language

Professional details

2002:	English manuscript of extinguishing tank fires (99 pages)
1999:	scientific articles in different journals (11 articles)
1998:	27 patents applied for
1998:	giving lectures in national and international conferences (8 lectures)
1995:	supervisor of theses in Ybl Miklós College (5 theses)
1992:	winner of 'BM TOP environmental-friendly extinguishing materials'
1990:	developing instant foam systems

1990:	member of GTE Fire Management Department
1988:	developing the Impulse Fire Extiguishing procedure
1982:	managing director of IFEX Engineering Office
1980:	58 patents subsisted

Prizes, recognition

2005:	golden medal of WIPO/UN
2003:	Environmental-friendly Product classification
2002:	Kornél Szilvay medallion
2001-2002:	participant of Dreamers' Dreams Exhibition
1992:	silver medal of Invention Expo Geneva