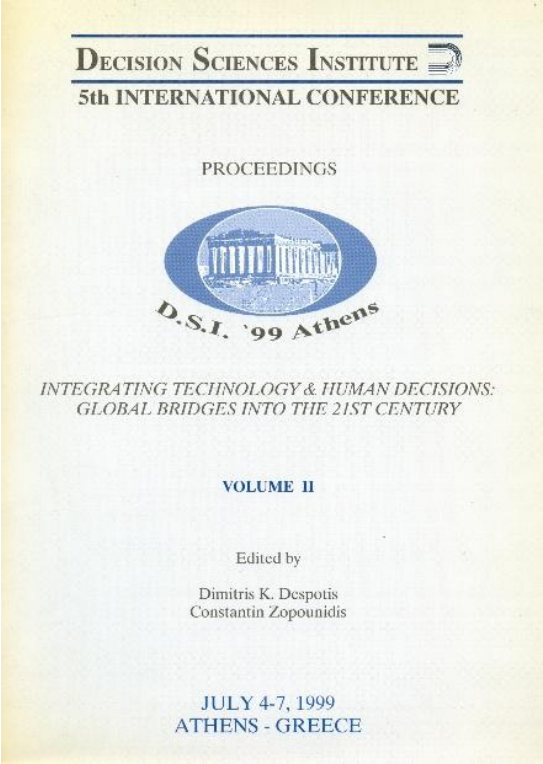

OPTIMIZATION OF THE HYDROCARBON STORAGE PARK AT A MARINE TERMINAL LEVEL

D. Aïssani, S. Adjabi, S. Meftaly, S. Haddad
L.A.M.O.S
Laboratory of Modelisation and Optimization of Systems
University ofBéjaïa, 06 000 (Algeria)

ABSTRACT

In this work, we propose a modelisation methodology of the process of reception, storage and expedition of oil at amarine terminal level. After the analysis of the system, a discrete-event simulation model is established and validated. The study of the storage evolution, according to supplementary capacity to be installed, of oil quantities received and the predicted exports is achieved. The proposed optimization model constitutes a tool for decision making. The storage capacity to be installed is varied in order to determine the ships dwell time, the frequencies and the line stop lengths, as well as the incurred costs. The results derived from the application of the proposed mode lto the Marine Terminal of Bejaïa (Algeria) are presented.

DECISION SCIENCES INSTITUTE

5th INTERNATIONAL CONFERENCE

PROCEEDINGS

D.S.I. '99 Athens

INTEGRATING TECHNOLOGY & HUMAN DECISIONS: GLOBAL BRIDGES INTO THE 21ST CENTURY

VOLUME II

Edited by

Dimitris K. Despotis
Constantin Zopounidis

JULY 4-7, 1999
ATHENS - GREECE

OPTIMIZATION OF THE HYDROCARBON STORAGE PARK AT A MARINE TERMINAL LEVEL

D. Aïssani, S. Adjabi, S. Meftaly, S. Haddad
L.A.M.O.S
Laboratory of Modelisation and Optimization of Systems
University ofBéjaïa, 06 000 (Algeria)

ABSTRACT

In this work, we propose a modelisation methodology of the process of reception, storage and expedition of oil at amarine terminal level. After the analysis of the system, a discrete-event simulation model is established and validated. The study of the storage evolution, according to supplementary capacity to be installed, of oil quantities received and the predicted exports is achieved. The proposed optimization model constitutes a tool for decision making. The storage capacity to be installed is varied in order to determine the ships dwell time, the frequencies and the line stop lengths, as well as the incurred costs. The results derived from the application of the proposed mode lto the Marine Terminal of Bejaïa (Algeria) are presented.

INTRODUCTION AND POSITION OF THE PROBLEM

The politics of hydrocarbons exports of a productor country is bound by many factors (the worldwide market situation, quotas assigned by the OPEC, upkeep of works, capacity of investment,...). The balance between resources and outlets must be achieved at every instant, at all levels of the oil chain : in harbors to reduce times of oil tanker waiting, at the level of pipelines to avoid interruption,... For this, storage appeared indispensable at every load rupture point. However, a bad estimation of storage capacities (of hydrocarbons) installed at a marine terminal level can causeserious perturbations in the oil activity progress.

The application to the marine terminal of Béjaïa (Algeria) permits to answer the question : will the storage capacitiesof the Direction de Transport Centre Sonatrach be able to face the objectives of the Algerian National Oil CompanySonatrach at the horizon 2001 ?

At the present time, the available storage capacities of the marine terminal of Béjaïa are : 12 ferries of 35 000 m^3 (with a useful volume of 27 000 m3) and 04 ferries of 50 000 m^3 (with a useful volume of 40 500 m^3). 06 ferries of 35 000 m^3 and one ferry of 50 000 m^3, that is to say 200 000 m^3, are affected to oil condensat storage, while 04 ferries of 35 000 m^3 and 02 ferries of 50 000 m^3, that is to say 190 000 m^3, are affected to the crude oilstorage. A mean set of03 ferries are always put out of service for maintenance operation.

To determine a possible extension of storage park of the different regions, a study was achieved in 1997 by the CRD (Research Center and Development Sonatrach, Boumerdès) [2]. C.R.D. proposes the extension of the marine terminal of Béjaïa by a storage capacity of six (6) ferries (two ferries of 50 000 m^3 and two ferries of 35 000 m^3 intended to the crude oil storage, and two ferries of 35 000 m^3 intended to oil condensat storage). Nevertheless, it clearly appears that several parameters of the real system were not taken into consideration (cf. [3]).

THE ADOPTED METHODOLOGY

The adopted methodology consists of simulating the process of reception, storage and expedition of oil on a yearly period basis recovering the emptied space. The principle of the adopted approach consists of varying the extra storage capacities to provide for in view to determine the mean yearly time periods of line stops and ships dwell time due to a lack of product, buisy terminals and/or wheather perturbations. After several simulation trials, an estimate of the costs corresponding to the installation of new storage capacities (of new ferries of storage) as well as the costs corresponding to the ships dwell time. The extra capacity to be installed is that one that presents the least cost.

DESCRIPTION OF THE SIMULATOR

During the simulation process, the instant of interest are those when an event appears. Every event is characterized by following attributes :

- Hour of occurrence : is the hour where the event is supposed to occur.
- Procedure of treatment: this consists of all the actions associated to the event.

During the simulation stage, the different events are generated and ordered chronologically. The first task of the simulator is to make sure that the events chronology is respected. The Simulator management is organised as follows:

- A central clock that affects to each instant the simulation system hour which corresponds to the current event occurrence hour.
- An event table lists the different event chronologically.

At each event occurrence the associated actions are taken: The simulator core engine is a procedure that, at each step picks up the event at the top of the list and executes the

corresponding procedure. This procedure execution may create new events which in turn are recorded in the list as well as cancel or postpone other events.

SIMULATOR PARAMETERS ASSESSMENT

Let Q_tot = Quantity of oil (crude and condensat) transported over a year on the pipeline OB1. To minimize the total stops duration of the line, it is necessary that Q_tot takes the smallest value. However Sonatrach must honor its contracts of export, then Q_tot must be superior to the predicted quantity.

The different cases of working are represented as follows :

Expedition flow rate of H.E.H. (m^3 / hour)	800	1400	1800	2200	2600
Reception flow rate to Béjaïa (m^3/hour)	340	940	1340	1740	2140
Q_tot m^3	2978 400	8 234 400	11 738 400	15 242 400	18 746 400

Table 1: Reception flow rate at the Marine Terminal ofBejaïa

At the horizon 2001, Sonatrach predicted a total of 14 305 555 m^3exports, therefore the mean reception flow rate must be a combination of the two previous debits 1740 and 1240 m^3 / hours.

RESULTS OF THE SIMULATION

The simulation trials permitted the observation of the evolution of the storage process according to the extra capacity to installed. A system run is simulated using 150 iterations, each which spanned other period of one year (8760 hours). An excit test is provided for in view to respect this period duration. Results of the iteration represent the total length of stops of the line and the different time duration of the ships dwell period (unavailability of the product, harbor busy, waitings for occupied station). Results of the simulation are the arithmetic means of the set of values obtained.

Presentation of results:

Results of simulation experiences corresponding to the different variants (extra capacities to be installed for each of the products) are summarized in table 2 :

Variant	Number of supplementary Ferries for oil crude	Number of supplementary ferries for oil condensat	Waiting bad weather	Waiting occupied station	Waiting product	Line Stops
1	0	0	3443.88	448.69	1016.81	376.53
2	1	0	2940.81	192.88	232.44	231.33
3	1	1	3314.32	172.98	205.30	179.76
4	2	1	2842.76	149.18	194.25	120.21
5	2	2	2903.39	180.20	190.78	121.34
6	3	1	3199.67	137.33	172.22	75.01

Table 2: Results of the simulation

Discussion of results

The reception flow rate considered during simulation is equal to 1633 m^3 /h, whereas machines (motors, pumps and turbines) available at the pumping stations permit to achieve a debit maximum of 1650 m^3 /h, that is a difference of 17 m^3 /h. Therefore when switching to a debit of 1650 m^3 /h, Sonatrah will be able to transport 17 * 8760 = 148920 m^3 supplementary.

Sensitivity analysis:

This analysis must follow the presentation of results of a simulation model. Indeed, it permits the observation of the behavior of the simulated system according to variations of its input parameters. The main input parameters ofthe simulator are the number of supplementary ferries to install for each of the two products (crude oil and oil condensat) and predicted quantities to the export from the harbor of Béjaïa (cf [3]).

Optimization:

The mean life expectancy of a storage ferry is estimated to be 25 years. Therefore, the costs corresponding to each variant are calculated for a period of 25 years :

$$CV_i = C_1N_{1i} + C_2N_{2i} + C_3N_{3i}$$

where :

CV_i is the cost of the i-th variant

C_1 is the construction cost of a storage ferry with a capacity of 50 000 m^3, which is 199 389 030 dinars.

C_2 is the waiting cost of a cistern ship for lack of product (unavailability of the product), for one hour, it is equal to 203 12 dinars.

C_3 is the price of one oil m^3 equal to 5300 dinars.

N_{1i} represents the total number of supplementary ferries to install.

N_{2i} correspond to the total waiting time of ships for lack of product.

N_{3i} is the oil volume that has not be transported because of the line stops (lack to transport).

The derived results are given in table 3 :

Variant	Lack to transport annually (m3)	Yearly cost of the lack to transport (DA)	Cost of the ferry installation (DA)	Yearly cost of the waitings product (DA)	Total cost on 25 years (DA)
1	614873.49	3258829497	0	206553444.72	81987073543
2	377761.89	2002138017	199389030	4721321.28	50171682846.3
3	293548.08	1555804424	398778060	4170053.60	39398140000
4	196302.93	1040405529	598167090	3945606.00	26706945465
5	198148.22	1050185566	797556120	3875123.36	27149073361.5
6	122491.33	649204049	797556120	3498132.64	17115110661

Table 3: Costs of the variants.

The analysis of results in the Table 3 shows that the sixth variant, i.e. the installation of three supplementary ferries of 50 000 m^3 each for the crude oil storage and a ferry of the same capacity for the oil condensat storage, represents the least expensive solution for the Sonatrach Compagny.

REFERENCES

[1]Aïssani, D. (1987), *Modélisation and Simulation of an Industrials Systems.* Post-Graduate course, University of Annaba.

[2]C.R.D., (1997), *Simulation du Processus de Stockage*, Rapport Interne, Ed. C.R.D. Sonatrach, Boumerdès.

[3]Meftali, S., and Haddad, S. (1998), *Optimisation du Parc de Stockage des Hydrocarbures au niveau de l'U.T.C. Sonatrach Béjaïa*, P.F.E., Université de Béjaïa.

[4] Ranks, J., and Carson, J., and Nelson, B.L. (1995), *Discrete Event System Simulation*, Ed. Prentice Hall, New Jersey.

OPTIMIZATION OF THE HYDROCARBON STORAGE PARK AT A MARINE TERMINAL LEVEL

D. Aïssani, S. Adjabi, S. Meftaly, S. Haddad
L.A.M.O.S
Laboratory of Modelisation and Optimization of Systems
University ofBéjaïa, 06 000 (Algeria)

ABSTRACT

In this work, we propose a modelisation methodology of the process of reception, storage and expedition of oil at amarine terminal level. After the analysis of the system, a discrete-event simulation model is established and validated. The study of the storage evolution, according to supplementary capacity to be installed, of oil quantities received and the predicted exports is achieved. The proposed optimization model constitutes a tool for decision making. The storage capacity to be installed is varied in order to determine the ships dwell time, the frequencies and the line stop lengths, as well as the incurred costs. The results derived from the application of the proposed mode lto the Marine Terminal of Bejaïa (Algeria) are presented.