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Using Statistical-Mathematical Methods and Computing Technique in the Rate Setting of Oil Products Unloading

The utilization of methods of mathematical statistics has been extended in most production branches, for the activity of labour standardization and especially for the working out of labour norms, in our country. The graphic method of setting the standard curve and on a more reduced scale, the method of the leasts squares and of multiple correlation have started being applied, experimentally.

In this paper, the authors present a method of standardizing the unloading/loading of oil products from railway oil/tankers into/from the storing reservoirs of an export station, a method which may be extended in oil fields and refineries for similar operations.

As is known, in establishing the labour rate setting in tons/hour the unloading time (τ) is interfering, considered from the moment of introducing the down-and-up-train into the point of unloading until the notification of the empty train. This time is a random size whose value differs from one train to another, according to the rheological characteristics of the product (expressed by viscosity, congealment, temperature upon arrival, etc.), by the temperature of environment, by the number of oil tankers within the down-and-up-trains liable to unloading, the pressure and temperature of the steam (which influences the heating time, the diameter of the in-take pipes into the storehouse installation, etc.).

In the following, the sizes: the diameter of the in-take pipes, the flow of pumps, the steam pressure and temperature were considered as constant.

It results that the unloading time of the trains is given by relation of the form:

$$\tau = f(G, n, d, v, C, t_p, t_e) \qquad (1)$$

for black products (crude oil, oils and similar products from the rheological point of view) and

$$\tau = f(G, n, d, t_e) \qquad (2)$$

for white products (gas oil, benzine and similar products from the rheological point of view) where:

G represents the quantity of oil products in the train, in tons;

n — the number of tank cars of the respective train;

d — the density of the product to be unloaded at 15°C (d_4^{15});

v — the viscosity of the product in °E to 50°C;

C — congealing of the product, in °C;

t_p — temperature of the product at the moment of side-tracking the train, in °C;

t_e — average temperature of the air (daily average), in °C.

As the relations are non -linear viscosity and congealing are introduced into liniarized values.

In this way, for transforming the congealing point values expressed in °C into liniarized units, the corresponding values in the tables presented in [2] are read. At the same time, in [2] the conversion of viscosities into linearized units is done from centistokes (cst) and therefore, [3] will be used for turning the viscosity from °E to 50°C in cst.

The statistical data of the trains unloaded in the last 6 months in a storing unit in our oil industry are presented in table 1.

Table 1

Statistical data to be processed on the electronic computer with the aid of the REMUS program

No	Unload. time. Hours	Quantity Tones	Number alembics	t_p	d_4^{15}	Visc. I.A	Cong. I.A	t_e °C
1	33.50	1670	50	23	0.914	28.20	19.4	14
2	19.00	1568	45	25	0,955	36.00	43.8	7.2
3	13.00	1631	49	18	0.914	28.20	19.4	2.8
4	17.00	1534	43	47	0.936	34.20	77.4	2.8
5	10.00	1677	43	17	0.904	32.50	97.6	−1.4
6	30.00	1623	46	23	0.937	33.90	50.2	−1.4
7	24.00	1624	45	35	0.948	34.60	43.8	0.9
8	22.50	1566	42	54	0.935	34.00	71.0	−0.2
9	16.00	1598	45	40	0.953	37.34	43.8	14
10	18.00	1632	48	42	0.923	33.88	77.4	14
11	14.00	1654	45	24	0.955	36.61	43.8	5.6
12	20.50	1637	47	47	0.950	35.71	43.8	8.5

We shall suppose relations (1) and (2) linear, namely.

$$\tau_n = K_0 + K_1 G + K_2 n + K_3 d + K_4 v + K_5 C + K_6 t_p + K_7 t_e \qquad (3)$$

$$\tau_a = K_0 + K_1 G + K_2 n + K_3 d + K_4 t_e. \qquad (4)$$

The statistical data in table 1 processed with the aid of multiple correlation, by using the REMUS program, on the IBM 370 electronic computer of the Economic Cybernetics Department within the Academy of Economic Studies have led to the following results:

For the black products:

$K_0 = 45.865891$ $\quad K_4 = 0.090795$

$K_1 = -0.001987$ $\quad K_5 = -0.010495$

$K_1 = 0.035757$ $\quad K_6 = -0.044875$

$K_3 = -26.763504$ $\quad K_7 = -0.54724$

The multiple correlation coefficient = 0.76
Standard deviation = 2.89
Variation coefficient = 18.78

It results that: the time set with the aid of the electronic computer for unloading a train with black oil products (crude oil, oils, rock oil and similar oil products from the rheological point of view) is given by relation:

$$\tau_n = 45.865891 - 0.001987G + 0.035757n - 0.044875t_p - \\ - 26.763504d + 0.090795v - 0.010495C - 0.54724t_e. \qquad (5)$$

For white products:

$K_0 = 6.968446$

$K_1 = 0.00027$

$K_2 = 0.011392$

$K_3 = -1.784068$

$K_4 = -0.041901$

The multiple correlation coefficient = 0.551
Standard deviation = 0.655
Variation coefficient = 10.798.

It results that the time set with the aid of the electronic computer for unloading a train with white products (petrol, gas oil and similar products from the rheological point of view) is given by relation:

$$\tau_a = 6.968446 + 0.00027G + 0.011392n - 1.784068d - 0.041901t_e. \qquad (6)$$

The production norm N_p in tons/hour is given by relation:

$$N_p = \frac{G}{\tau} \cdot k_s$$

where:

G — represents the quantity in tons registered in the weight note of the train;

τ — the unloading time established according to ratios (5) and (6);

k_s — the simultaneity coefficient of the trains on the unloading platform lines (its influence on the unloading norm is being felt and it is applied only for the trains for which $k_s > 1$).

Example of method application

We shall suppose that in a certain time period, for example, ten days, trains with white and black products have been unloaded into an oil product store, according to tables 2 and 3.

By calculating the simultaneity coefficient k_s (by reporting the sum of the time standardized with the aid of the electronic computer —τ — for the white and black products to 240 hours) it is noted that beginning with the date corresponding to train 1007 for white products and 917 for black products k_s becomes greater than 1 the time is corrected with the formula:

$$\tau_c = \frac{\tau}{k_s} = \frac{\tau}{1 \cdot 5339}.$$

The unloading norm is correspondingly corrected as follows:

$$N_p = \frac{G}{\tau_c} \quad \text{tons/hour.}$$

The time τ obtained was inferred from the relations provided by the IBM 370 electronic computer with the aid of the REMUS program. Relation (5) and respectively (6) has been applied for each train taken separately also using the FELIX FC 15 and FELIX FC 30 S invoicing and accounting electronic machines.

As regards the efficiency of the presented method, it can be pointed out that its application has led to an increase in the stability of workers, of labour productivity, the diminishing of the stand time for the tank cars and the increase of the index of using the number of waggons.

This method may also be extended in oil fields and refineries as well as in other sectors of activity implying the unloading/loading of liquid products from/into railway oil tankers.

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Table 2

No crt	train No	G tons	n	d	t_e °C	τ Hours	τ_e	$\frac{G}{\tau}$	$\frac{G}{\tau_e}$	lei / tone	lei / TRAIN
1	614	1197	36	0.734	19.9	5.552	—	236	—	0.246	294.46
2	724	1547	46	0.751	19.9	5.732	—	270	—	0.197	304.76
3	1	196	7	0.795	19.9	0.883	—	222	—	0.239	46.84
4	723	507	24	0.751	20.2	5.200	—	97	—	0.547	277.32
5	1005	1771	40	0.749	20.2	5.727	—	309	—	0.172	304.61
6	725	1109	43	0.745	20.2	5.590	—	198	—	0.268	297.21
7	721	130	3	0.755	20.2	0.986	—	147	—	0.361	46.93
8	1007	1641	33	0.745	20.6	5.578	—	294	—	0.180	295.38
9	727	1207	47	0.736	20.6	5.636	—	214	—	0.248	299.33
10	726	1575	55	0.714	20.7	5.866	—	268	—	0.198	311.85
11	728	1406	51	0.764	21.3	5.686	—	247	—	0.216	302.29
12	725	110	6	0.737	21.3	0.495	—	222	—	0.239	26.29
13	1001	1746	40	0.749	21.3	5.679	—	307	—	0.173	302.05
14	729	1427	39	0.764	21.3	5.555	—	257	—	0.207	295.38
15	1004	1500	34	0.750	22.9	5.458	—	275	—	0.193	289.50
16	2	160	5	0.70	22.9	0.721	—	222	—	0.239	38.24
17	730	1328	48	0.758	23.7	5.516	—	341	—	0.220	292.16
18	731	1234	39	0.759	23.7	5.386	—	229	—	0.231	285.05
19	1001	1683	39	0.747	23.8	5.529	—	304	—	0.174	292.84
20	752	1141	38	0.761	23.8	5.346	—	312	—	0.249	284.10
21	1005	1764	40	0.747	24.0	5.562	—	317	—	0.167	294.58
22	733	1100	48	0.752	24.0	5.464	—	201	—	0.264	290.40
23	1007	1810	40	0.750	23.2	5.611	3.658	—	495	0.107	193.67
24	734	923	34	0.759	23.2	5.287	3.447	—	268	0.198	182.75
25	732	521	23	0.755	23.2	5.060	3.299	—	158	0.336	175.05
26	1002	1721	59	0.755	23,2	5.566	3.628		474	0.112	192.75
27	735	1307	46	0.755	23.5	5.534	3.668	—	362	0.147	192.13
28	736	1375	53	0.755	23,5	5.632	3.672	—	374	0.142	195.25
29	1001	1782	40	0.753	23.5	5.598	3.649	—	488	0.109	194.24
30	733	549	24	0.758	23,5	5.074	3.308	—	166	0.203	175.68
31	1008	1785	40	0.751	23.4	5.602	3.652	—	488	0.109	194.56
32	737	1141	45	0.755	23.4	5.478	3.559	—	320	0.166	189.40
33	100	1266	45	0.871	23,4	5.305	3.458	—	366	0.145	183.57
34	1005	1782	46	0.756	22.0	5.702	3.717	—	479	0.111	197.80
35	738	1331	58	0.752	22.0	5.725	3.750	—	355	0.150	199.65
										TOTAL:	7938.07

Table 8

Black products
TRAIN

no.	G tons	n	t_p	d_4^{15}	Visc. *I.A.*	Cong. *I.A.*	t_e	τ Hours	τ_e Hours	G/τ t/h	G/τ_e t/h	Lei ton	Lei Train
4002	1695	35	41	0.925	31.86	40.9	19.9	8.544	—	198	—	0.268	454.26
4010	1857	36	39	0.952	31.86	43.8	20.5	7.447	—	249	—	0.213	395.54
4006	1796	35	30	0.927	33.10	80.7	20.7	8.222	—	218	—	0.244	438.22
301	52	1	30	0.896	31.31	22.9	20.7	0.477	—	109	—	0.487	25.32
511	1544	40	40	0.988	32.26	87.1	20,7	6.674	—	231	—	0.229	353.47
4008	1910	36	41	0.943	36.20	43,8	20.7	7.867	—	243	—	0.219	418.29
512	1354	38	39	0.989	34.77	90.4	20.7	7.168	—	189	—	0,281	380.65
4001	1891	36	39	0.948	36.75	45.2	21,3	7.479	—	253	—	0,210	397.11
4011	1865	36	40	0.958	37.23	43.8	22.0	6.893	—	271	—	0.196	365.54
513	1156	34	43	0.987	34.95	80.7	22.1	6.671	—	173	—	0.307	354.95
302	1114	35	39	0.898	30.86	94.0	22.1	8.842	—	126	—	0.421	469.64
4002	1785	36	40	0.958	37.23	43.8	23.7	6.147	—	290	—	0.183	326.96
914	1327	40	41	0.957	34.60	77.4	23.7	8.948	—	148	—	0.359	476.28
4006	1887	36	40	0.959	34.60	43.8	23.7	5.651	—	334	—	0.159	300.11
4003	1815	36	40	0.963	37.12	71.0	23.7	6.634	—	322	—	0.165	299.41
456	1837	39	42	0.948	33.10	74.2	24.0	5.479	—	335	—	0.159	292.08
4002	1607	31	40	0.947	34.68	45.2	24.0	6.180	—	260	—	0.204	328.32
4011	1750	34	39	0.943	34.77	45.2	23.0	6.603	—	265	—	0,200	350.79
4004	1908	35	40	0.955	36.15	43.8	23.2	6.098	—	313	—	0.170	323.81
453	1658	49	41	0.917	32.93	42.4	23.2	7.807	—	212	—	0.251	415.44
917	1124	38	41	0.956	35.71	77.4	23.5	7.132	4.650	—	242	0.219	246.72
4006	1873	36	40	0.940	33.10	45.2	23.5	6.148	4.008	—	467	0.114	213.52
920	1359	44	40	0.951	35.66	65.3	23.4	7.238	4.719	—	288	0.184	250.06
301	575	19	41	0.950	35.08	53.2	23.4	7.959	5.189	—	111	0.478	274.85
301	1077	32	40	0.919	31.31	74.2	23.4	7.771	5.066	—	212	0.250	269.25
922	1540	46	39	0.971	34.68	62.8	23.4	6.424	4.188	—	368	0.144	221.76
302	1582	46	35	0.897	31.31	87.1	22.0	8.719	5.684	—	275	0.193	301.47
4010	1794	36	41	0.897	34.21	77.4	22.0	7.995	5.212	—	344	0.154	276.28

UTILISATION DES METHODES STATISTIQUES-MATHEMATIQUES ET DE LA TECHNIQUE DE CALCUL DANS LA REGLEMENTATION DU TRAVAIL DE DECHARGEMENT DES PRODUITS PETROLIERS

Pour l'activité de réglementation du travail et surtout pour l'élaboration des normatifs du travail, on utilise dans notre pays, dans la plupart des branches productives certaines méthodes de la statistique mathématique. A l'élaboration des normatifs du travail on vient d'appliquer de façon expérimentale la méthode graphique du traçage de la courbe normative et, à une échelle plus réduite, la méthode des plus petits carrés et de la corrélation multiple.

Les auteurs présentent une méthode de réglementation de l'activité de chargement-déchargement des produits pétroliers des wagons-citernes dans les réservoires-dépôts — et l'inverse-dans une station d'exportation, méthode pouvant être appliquée aussi pour des opérations similaires sur les chantiers pétroliers et dans les raffineries.

ПРИМЕНЕНИЕ СТАТИСТИКО-МАТЕМАТИЧЕСКИХ МЕТОДОВ И ВЫЧИСЛИТЕЛЬНОЙ ТЕХНИКИ В НОРМИРОВАНИИ ТРУДА ПРИ РАЗГРУЗКЕ НЕФТЯНЫХ ПРОДУКТОВ

В нашей стране для деятельности по нормированию труда и в особенности для разработки рабочих нормативов, в большинстве производственных отраслей применяются методы математической статистики. Экспериментально начали пользоваться в разработке рабочих нормативов графическим методом намётки нормативной кривой и в меньшем масштабе методом квадратиков наименьшей величины и соотношением кратного числа.

В настоящей работе авторы знакомят с методом нормирования деятельности разгрузки-погрузки нефтяных продуктов из вагонов-цистерн в складские резервуары экспортной станции, метод, который может быть применён на нефтескважинах и на нефтеочистительных заводах при таких же операциях.

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