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ROUTINE LABORATORY CONTROL OF PAPER BAGS

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The primary claim on bag packing is sufficient mechanical strength to stand the stress at the filling and during the whole transporting and storing processes to the consumers. As a rule the mechanical strength of the paper bag is influenced by the chemical properties of the packaged article. The constituents of superphosphate and potash superphosphate, here being of importance above all, are phosphoric acid, hydrofluoric acid, hydrofluosilic acid and hydrochloric acid gas. The strength of the paper is greatly deteriorated by these chemicals. A paper bag for the said products is therefore built up by one or two plies of pitched paper and outside 2 - 4 kraft paper plies. The main task of the pitched paper is to prevent influence from these fluid and gas - eous materials on the outer paper plies.

In particular the continued formation of gaseous hydrochloric acid in granulated potash superphosphate makes it necessary that the pitched paper is strong enough to prevent the gas penetrating it. When this product was placed on the market a few years ago, complaints increased markedly owing to bursting when packed. At the same time important differences were observed in paper bags delivered from different manufacturers both with regard to the quality of the pitched paper and the mechanical strength of the new bag. These circumstances led to a compulsory delivery control of all paper bags.

According to the above this control should cover the mechanical strength at the time of delivery and the power of the pitched paper to prevent gas penetration. The results of tests must be sufficiently clear to assess the suitability of the bag for the lines of goods in question. Besides a necessary condition was that the tests were to be so simple that they could be carried out on all deliveries of a total of 12 million bags a year.

Mechanical strength

The greatest mechanical stress of a superphosphate bag corresponds as a rule to a free drop from 1.5 - 2 m height. In this way the bag reaches a velocity of about 5 m/sec. at the constricting impact. It is evident that the usual testing methods for tension, elongation, folding and tearing [1) 2)] only measure statistical probabilities which cannot be expected to correspond t the practical stresses. For this it is necessary to measure the impulse force at the velocity of at least 5 m/sec.

An impulser, constructed for this purpose has been proved t give results very near to the actual strength of filled bags and compared with the results from a drop testing laboratory 3) 4). For measuring, a 10.0 mm wide paper strip is stretched between a pendulum and an impact clamp with the initial die opening 100 mm. The impact clamp is started with an initial speed of 10 m/sec. The strip is torn off by this strong pull and the impulse transmitted to the pendulum, before the strip has been torn off, is recorded by the pendulum stroke. The pendulum scale is suitably graduated in millinewton seconds (mNs). The accuracy is usually correct to 1 mN (The theory of the testing is referred to in the literature 3).

Besides reliability the test described is characterized because it can be carried out with large numbers. It was therefore chosen for routine delivery testing.

Strength number.

In the reports on experiments the quotient between impulse strength and paper weight is also stated and is called strength number. This is of primary interest to the paper manufacturers but is of little importance to the bag consumers.

Gas penetration.

The pitched paper used by us is built up by a bitumen layer which is covered with paper plies on both sides. We have chosen th water vapour permeability as a measure of the gas penetration of the paper. This is determined according to a modification of the IG Farben method 5). A paper disk, Ø.89 mm, is fixed in a light metal box containing 30 ml water. The box is kept in air, dried with 95% sulphuric acid at 25°C. The difference in weight after the first and second day is determined and converted into g H_2O/m^2, 24 h The method gives an accuracy of ± 1 g H_2O/m^2 ·24 h.

The most common of TAPPI's methods 6) gives considerably lower values. We have found it suitable to get large values giving a clear deviation for unevennesses in the coating. (It may be possible that the determination of the air permeability could give somewhat simpler and prompter routine work than the method chosen by us.)

Other determinations.

In order to check that the specifications in the bag orders are correct, the paper and the bitumen weights are determined.

The weight of paper is determined by weighing disk, Ø.89 mm, on an analysis balance.

It is obvious that the larger the sample sheet that is weighed the more the individual result approaches the average for the paper roll as a whole, i.e. a study of unevennesses in the paper roll is made impossible. In particular we wish to know the amount of unevenness in pitched paper, and it is obvious that very small samples must be taken to obtain accuracy of measurement. Our method gives an accuracy better than ± 0.5 g/m^2, which is satisfactory. Considerable unevenness occurs in our tests. Our method has been evolved because we wished to adjust in accuracy and to locate unevenness.

The weight of bitumen is determined by weighing disks, Ø.89 mm and extracting with triethylene chloride in soxhletapparatus. The remaining paper disks are dried, conditioned and weighed. The bitumen weight is estimated as the difference. An accuracy of ± 1 - 2 g/m^2 is obtained.

Working routine.

From each delivery of 25,000 bags 8 bags from different bundles are taken out at random. 4 bags are sent together with a form giving the necessary data to the testing laboratory. The remaining bags are kept in a good storage place until the testing record has been received or until the laboratory requires them for control test. The control test is carried out when the average for a bag deviates more than 20% from the average for the delivery.

At the laboratory two disks from each ply of the bags are taken out for determination of bitumen and paper weights, also two strips in the longitudinal direction and two strips in the latitudinal direction for the determination of the impulse strength (Fig. 1). The paper samples are conditioned at the laboratory (20°C air temperature and 60% rel. humidity) at least one day before carrying out the determinations.

The results are given as average and standard deviation for the whole delivery.

$$\text{Average} = \bar{X} = \frac{\sum X}{N}$$

$$\text{Standard deviation} = S = \sqrt{\frac{\sum (X - \bar{X})^2}{N - 1}}$$

X = individual observation

N = number of observations

The laboratory can be organised in such a way that all work is carried out by one working chemist.

In figures 2 and 3 examples are given of testing records from two bag deliveries. The first example is for the type of bag most commonly used for superphosphate with an inner pitched paper with the total weight of 125 g/m^2 and the content of bitumen 40 g/m^2 and four kraft papers at 75 g/m^2. The other example is for bags intended for PK with two inner pitched papers at 100 g/m^2 total weight and each containing 30 g/m^2 bitumen and three kraft papers at 75 g/m^2. In this case the laboratory has noticed the fact that the bitumen layer is too thin and the vapour permeability too high.

In Table 1 a comparison of the results obtained during four months is shown.

Result.

The delivery control of paper bags has now been going on for about two years. Our seven sack suppliers have shown a great interest in it and have been stimulated to take steps to improve quality.

The strength number has shown a remarkable tendency to increase. At the same time the weight of paper has proved to be very uniform. This could be exploited so that an increase in the price of paper was compensated by a reduction of 7% in the weight of the paper. In spite of this the impulse strength is now constantly higher than at the beginning of the control. A further reduction of the paper weight is possible and would probably not have a detrimental effect on its usefulness. (Unfortunately this still causes technical production difficulties for the paper manufacturers).

The vapour permeability of the pitched paper has shown great variations. There is a certain connection in the bitumen weight in deliveries from the same suppliers (fig. 4). As will be seen from the graphs there are great variations between different manufacturers and this seems to depend on different qualities of bitumen and above all on different coating techniques.

Some manufacturers have met our complaints about a too low bitumen weight and a too high vapour permeability by thickening the bitumen layer appreciably. Owing to this, excellent permeabili figures have been obtained. Other manufacturers have improved thei methods for the bitumen coating and have in this way arrived at goo results.

As we have received claims for compensation on burst bags, these claims have been compared with the results of testing the ba delivered at that time. In the cases when the results of testing have shown a bag quality lower than our specifications or low in comparison with other bag deliveries, the bag suppliers have paid our costs in connection with the claims for compensation (the cost for new bags and re-bagging). The number of claims has as yet been so small that no statistical estimates in relation to the testing results could be done.

Our costs for the routine bag control amounts to 0.4 - 0.5 % purchase price of the bags. The economies which have been effected and can be effected owing to this control are considerably greater.

SUMMARY

The mechanical strength of paper is determined by measuring the impulse strength in a recently constructed apparatus. The power of the pitched paper to prevent gas penetration is expressed by determination of the water vapour permeability. These two determinations give an indication of the durability of bags in practi For the rest the weights of paper and bitumen are determined as a matter of routine as these values are used as order specifications. However, they do not give any direct measure of the durability of the bag in practice. Some results from two years routine control are mentioned, especially the possibilities of getting bags of higher quality at lower price.

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1) ASTM Standard, bd 7, Baltimore 1956.
2) Korn & Burgstaller: Handbuch der Werkstoffprüfung, bd 4, Berlin 1953.
3) Olle Andersson: An impulse method for measuring the impart strength of paper, Svensk Papperstidning 56 (1953) p. 403-411
4) Olle Andersson: Stossartige Beanspruchungen an Papier, Allgemein Papier-Rundshau, Heft Nr. 6, 1956.
5) I.G. Farbens metod föreslagen av Gemeinschaft Papierarkindustrie
6) TAPPI Standard No T 448 m.

Tabel I Comparison of results from sack testings during January - April, 1957

Supplier (sequence accidental)	Numbers of deliveries examined	Kraft paper weight g/m²	Impulse millinewton sec.				Strength number = impulse / g/m²				Union paper average					Notes
			Kraft paper average		Union paper average		Kraft paper average		Union paper average		Paper weight g/m²	Bitumen weight g/m²	Vapour perm. g H2O/m²/day	Standard dev. Bitumen weight, within average	Standard dev., vapour perm. within average	
			Longit. dir.	Latit. dir.	Longit. dir.	Latit. dir.	Longit. dir.	Latit. dir.	Longit. dir.	Latit. dir.						
A	14	74	10	12	17	13	0.13	0.16	0.15	0.12	79	32	33	9	7	
B	10	75	12	10	22	10	0.16	0.13	0.18	0.08	90	30	39	6	5	
C	38	76	14	11	20	16	0.18	0.14	0.16	0.12	98	31	32	4	6	
D	22	75	12	9	18	10	0.16	0.12	0.15	0.08	88	33	32	8	9	
E	18	76	12	10	22	14	0.16	0.13	0.16	0.10	92	47	27	8	6	
F	53	75	11	11	16	13	0.15	0.15	0.13	0.10	88	37	32	8	10	
G	17	77	10	13	17	19	0.13	0.17	0.12	0.14	90	47	26	11	9	

Fig. 2

SPECIFICATION
SPECIFIKATION
on bag deliveries to
över säckleverans till

Sample sent: / Prov avsänt: 18th Se
Sign.: IE
N:r 3

Manufacturer: / Tillverkare: (firm)
Order date: / Best. datum: Sept.6, 1956
Order no. / Order nr: 1662
Date of del.: / Leveransdatum: Sept.14, 1956
Way of del.: / Leveranssätt: By car E 7011
Number of bags in del.: / Antal säckar i lev.: 18.000
Type of bag: / Säcktyp: A-bag, sewn
Size of bag: / Säckformat: 43 x 9 x 91 cm with weak fold
Ply assemblage from inside - out / Bladsammansättning inifrån — ut,

1	2	3	4	5	6
125 g	75 g	75 g	75 g	75 g.	

Main measures of bags: / Provsäckarnas huvudmått:
Width: / Bredd: 43.0 cm
Length: / Längd: 91.1 cm
Gusset: / Sidoveck: 9.0 cm
Base width: / Bottenbredd: ---
Seam: / Sömmen:
Description: / Beskrivning: Overthread and underthrea rayon/nylon. Sewn through 50 mm crepe over the seam, enforced with a 30 mm w strip of kraft paper.
Distance from the edge: / Avstånd från kanten: 15.0 mm
Stich length: / Stynglängd: 7.8 mm

TESTING RECORD
PROVNINGSKONTROLL
of delivery control of paper bags
över leveranskontroll av papperssäckar
The work at Oskarshamn, The laboratory
Fabriken i Oskarshamn, Laboratoriet.

REYMERSHOLM

Ref. nr: 392
Sample arrived: / Prov ankom: Sept.19
Reported: / Rapporterat: Oct.22-56
Lab. sign: ES

Testing result: / Provningsresultat:

Average and standard deviation for bag 1 - 4
Medeltal och standarddeviation för säck nr 1—4.

Ply / Blad	Paper weight / Pappersv.		Bitumen w. / Asfaltv.		Vappour perm / Angperm.		Impuls l. r. long.		Impuls t. r. lat.		Strength / Styrket l. r. long.	Strengt / Styrket t. lat.
Nr	M	S. D.	M	S. D.	M	S. D.	M	S. D.	M	S. D.	M	M
1	89	2	39	4	28	5	18	4	15	2	0.14	0.12
2	75	1					10	3	13	2	0.13	0.17
3	76	2					12	1	12	3	0.16	0.16
4	75	1					11	2	11	3	0.15	0.15
5	77	3					11	2	11	2	0.14	0.14
6												

Notes: / Anteckningar: Total weight of union paper 128 g/m^2

The bitumen layer evenly and quite tight

Fig. 3

1

Sample sent:
Prov avsänt: Sept.9, 1956
Sign.: GR

SPECIFICATION
SPECIFIKATION
on bag deliveries to
över säckleverans till

Manufacturer:
Tillverkare: firm

Order date:
Best. datum: Aug.15, 1956

Order no.:
Order nr: Bag 1631

Date of del.:
Leveransdatum: Sept.12, 1956

Way of del.:
Leveranssätt: by rail 76567

Number of bags in del.:
Antal säckar i lev.: 24.750

Type of bag:
Säcktyp: PK, glued, open, serrated cut

Size of bag:
Säckformat: 50 x 12 x 95

Ply assemblage from inside- out
Bladsammansättning inifrån — ut,

1	2	3	4	5	6
100 ocean	100 ocean	75	75	75	

Main measures of sample bags:
Provsäckarnas huvudmått:

Width:
Bredd: 50.0

Length
Längd: 95.0

Gusset:
Sidoveck: ---

Base width:
Bottenbredd: 12.5

Sömmen:

Beskrivning:

Avstånd från kanten:

Styngländ:

TESTING RECORD
PROVNINGSKONTROLL
of delivery control of paper bags
över leveranskontroll av papperssäckar
The work at Oskarshamn, The laboratory
Fabriken i Oskarshamn, Laboratoriet.

Ref. nr: 391
Sample arrived:
Prov ankom: Sept.19
Reported:
Rapporterat: Oct.22,56
Lab. sign: ES

Testing result:
Provningsresultat:

Average and standard deviation for bag no 1 - 4
Medeltal och standarddeviation för säck nr 1—4.

Ply Blad	Paperweight Pappersv.		Bitumen w. Asfaltv.		Vapour perm. Ångperm.		Impuls long. Impuls l. r.		Impuls lat. Impuls t. r.		Strength long. Styrket l. r.	Strength lat. Styrket t. r.
Nr	M	S. D.	M	S. D.	M	S. D.	M	S. D.	M	S. D.	M	M
1	74	3	26	5	36	6	14	2	11	2	0.14	0.11
2	73	4	24	3	36	6	13	2	10	2	0.13	0.10
3	75	1					11	2	12	2	0.15	0.16
4	77	1					11	2	14	2	0.14	0.18
5	78	2					11	1	13	2	0.14	0.17
6												

Anteckningar: Total weight of bitumen paper no 1 = 100 g/m^2
2 = 97 "

The bitumen layer quite thin
The vapour permeability quite high. Not satisfadotry

Fig. 4.

The connection between vapour permeability and amount of bitumen for four different paper manufacturers. (The values being average for four months' periods.)