# Stock Preparation Strategies-Part-III: Comparison of Acid And Neutral Sizing

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**ABSTRACT**

*Neutral sizing of bamboo-hard wood mill pulp at pH of 6.7 to 7.3 has been carried out using a neutral sizing product (NSP) from sodium aluminate. The pulps have been bleached following to CEpHH and CEpHD bleaching sequences. The properties such as sizing, optical, filler retention and drainage of hand sheets produced from neutral sizing, have been compared with those of acid sizing (pH = 4.2-4.4). Talc has been taken as filler with varying addition levels.*

## INTRODUCTION

The three types of sizing employed in paper manufacturing are:

Acid sizing (pH 4.5-5)

Neutral sizing (pH 6.7-7.2)

Alkaline sizing (pH 8-9).

For the first two sizing rosin is employed, while in alkaline sizing the synthetic size AKD or ASA is used.

Neutral sizing technology was developed in Europe in mids 1980's which is under operation in many North American paper mills. Effective rosin sizing at neutral pH has two components:

- a dispersed rosin that is stable and chemically reactive above pH 7, and
- an aluminium source with sufficient cationic charge for bonding the dispersed rosin to the fiber at pH 7.

The basic requirements of neutral sizing is the presence of polynuclear species of aluminium reactive with the dispersed neutral size and effective retention systems to retain the size, fillers and fines (1).

Neutral sizing allows use of $CaCO_3$ which imparts enhanced optical, surface and printability properties (2). In acid sizing use of $CaCO_3$ is normally not possible. A new process has recently been developed where it can be used in acid media (3, 4).

Retention of aluminium ion varies directly with the carboxyl content of the pulp. Soft wood and bagasse pulp bleached with $ClO_2$ for the same rosin addition require less alum as compared to bamboo-hard wood mixed pulp. The carboxyl content in $ClO_2$ bleached pulp has been reported to be 2.06 to 2.6 meq instead of 6-8 meq. per 100g in CEH bleached pulp (15).

The present work has been carried out with the basic objective of showing that neutral sizing imparts enhanced properties compared to acid sizing.

## EXPERIMENTAL

The chemicals used here are same as in the earlier work (3,4). Bamboo-hard wood mixed mill pulps taken are:

1. CEPH sequence (abbreviated in text as CH)
2. CEPHD sequence (abbreviated in text as CD).

Acid sizing has been abbreviated in text as AS and neutral sizing as NS. CEpHH bleached pulp has been termed as CH and CEpHD as CHD.

Talc used here is from the mill. The addition levels and sequences in the two sizing modes are as follows:

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| Table-1 | | | | | |
|---|---|---|---|---|---|
| Compositions of sizes (CH-NS) | | | | | |
| Composition | Rosin (%) | Alum (%) | NSP (%) | Filler (%) | pH |
| I | 1 | 3 | 2 | 10 | 6.92 |
| II | 1 | 3.5 | 2.25 | 30 | 7.01 |
| III | 1 | 3.5 | 2.25 | 40 | 6.72 |
| IV | 1 | 4 | 3.25 | 25 | 6.71 |
| V | 1 | 5 | 3.75 | 5 | 6.60 |
| VI | 1 | 5 | 3.75 | 10 | 6.72 |
| VII | 1 | 5 | 3.75 | 20 | 6.97 |
| VIII | 1 | 5 | 3.75 | 25 | 6.94 |
| IX | 1 | 5 | 3.75 | 30 | 6.81 |
| X | 1 | 5 | 3.75 | 40 | 6.86 |
| XI | 1 | 5 | 3.75 | 50 | 6.86 |
| XII | 1 | 5 | 3.75 | 75 | 6.88 |

| | Acid sizing | Neutral sizing |
|---|---|---|
| Step I | Rosin (1%) | Rosin (1%) |
| Step II | Alum (1.82%) | Alum (5%) |
| Step III | - | NSP (3.75%) |
| Step IV | Talc (5-30%) | Talc (5-30%) |
| pH | 4.2-4.4 | 6.7-7.3 |

Thus normal sizing has been employed in both the sizing processes.

## RESULTS AND DISCUSSION

Compositions of sizes on pulp bleached with CEpH sequence by neutral sizing (CH-NS) are given in **Table-1.** 12 compositions have been studied. The rosin percentage is 1 and alum has been varied from 3 to 5%. The amount of neutral sizing product (NSP) has been varied from 2 to 3.75%. The filler added is from 5 to 75%, the pH having fixed to 6.7-7. In majority of the experiments, the filler content has been limited to <30%. The result with 75% filler addition is ineffective and it had been taken only for comparison purpose.

The drainage and cobb values of hand sheets are given in **Table-2.** The drainage time varies from 5.75

| Table-2 | | |
|---|---|---|
| Drainage and cobb values of sizes (CH-NS) | | |
| Composition | Drainage time (sec) | Cobb value (g/m$^2$) |
| I | 6.17 | 28.5 |
| II | 6.27 | Soaked |
| III | 5.75 | 46.5 |
| IV | 6.99 | Soaked |
| V | 5.06 | 21.7 |
| VI | 6.72 | 23.5 |
| VII | 6.97 | 23.8 |
| VIII | 6.94 | 19.9 |
| IX | 7.16 | 20.6 |
| X | 7.04 | Soaked |
| XI | 6.27 | 45.0 |
| XII | 7.0 | 45.2 |

| Table-3 | | | |
|---|---|---|---|
| **Optical properties of sizes (CH-NS)** | | | |
| **Composition** | **Brightness (% El)** | **Opacity (%)** | **Scattering Coefficient ($m^2/kg$)** |
| I | 73.8 | 81.8 | 30.8 |
| II | 75.6 | 81.5 | 32.5 |
| III | 75.8 | 81.7 | 32.7 |
| IV | - | - | - |
| V | 73.1 | 80.6 | 37.2 |
| VI | 74.1 | 81.3 | 40.3 |
| VII | 74.3 | 82.5 | 41.7 |
| VIII | 74.8 | 82.6 | 35.5 |
| IX | 72.1 | 82.2 | 37.0 |
| X | 73.0 | 86.8 | |
| XI | 77.0 | 81.4 | 46.7 |
| XII | 77.2 | 83.5 | 53.0 |

to 7.3 seconds which may be considered as remaining almost constant. As the compositions IX to XII have higher filler contents (30 to 75%), the drainage time in these systems is marginally higher. The cobb values for the last three compositions (X, XI and XII) and the first three (II, III and IV) are high or soaked and therefore considered unacceptable. The high cobb values in these samples appear to be due to high filler content (>30%). The optimum filler addition level may be $\leq$ 25%.

The optical properties of hand sheets are given in **Table-3.** The brightness of initial pulp was 85.3% El. Out of the sets having acceptable cobb value, composition VIII has the highest brightness value of 74.8% El. The opacity value (82.5%) is also highest in this composition. Composition VII presents optical properties in the similar range as in VIII; the scattering coefficient values in these two compositions being on the higher side (41.7 $m^2/g$ in VII and 35.5 $m^2/g$ in VIII).

The results of ash content and retention values given in **Table-4** show that the ash content in composition VII and VIII are also on the higher side,

| Table-4 | | |
|---|---|---|
| **Ash content and retention of (CH-NS)** | | |
| **Composition** | **Ash content (%)** | **Retention (%)** |
| I | 4.9 | 49.0 |
| II | 12.1 | 40.3 |
| III | 14.7 | 36.7 |
| IV | - | - |
| V | 4.1 | 82.0 |
| VI | 5.8 | 49.0 |
| VII | 9.8 | 42.7 |
| VIII | 10.7 | 41.3 |
| IX | 12.4 | 37.3 |
| X | 15.04 | 38.5 |
| XI | 17.2 | 34.4 |
| XII | 21.5 | 28.6 |

| Table-5 | | | | |
|---|---|---|---|---|
| **Compositions of sizes (CHD-AS)** | | | | |
| **Composition** | **Rosin (%)** | **Alum (%)** | **Filler (%)** | **pH** |
| XIII | 1 | 1.82 | - | 4.42 |
| XIV | 1 | 1.82 | 5 | 4.41 |
| XV | 1 | 1.82 | 10 | 4.45 |
| XVI | 1 | 1.82 | 15 | 4.20 |
| XVII | 1 | 1.82 | 20 | 4.30 |
| XVIII | 1 | 1.82 | 25 | 4.38 |
| XIX | 1 | 1.82 | 30 | 4.42 |

9.8 and 10.7% respectively with % retention of 42.7% and 41.3%. The compositions V and VI having acceptable cobb value, have high filler retention values (82% and 49% respectively) as the filler addition level in these two compositions is 5 and 10% only. The results indicate that for optimum neutral sizing, the system should have:

Rosin = 1%,

Alum = 5%,

NSP = 3.75%

with filler addition level of ≤ 25%.

The following part contains comparison of different properties on pulps bleached with CEpHD bleaching sequence between acid and neutral sizing. The results of acid sizing are given in **Table-5** and **6** and neutral sizing in **Table-7** and **8.** The filler retention and optical properties of both the sizing systems ae plotted in Figs. 1 to 5. The compositions of acid sizing are given in Table-5 (Compositions XIII to XIX) with rosin content of 1%, alum-1.82% and filler addition level varying from 5 to 30%. The pH in all the 7 compositions is almost constant (4-.20-4.45). In the compositions for neutral sizing (Table-7) (XX-XXVI), rosin is 1%, alum-5%, NSP is 3.75% and the filler addition level has been varied from 5 to 30%. The pH variation is from 6.7 to 7.34. The drainage time in acid sizing is from 6.9 to 10.5 sec. while the same in neutral sizing is from 8 to 10 sec. It may be infered therefore that the drainage time is marginally higher in neutral sizing.

The cobb values in acid sizing remain from 18.7 to 23.3 $g/m^2$ while in neutral sizing, it is very selective. Only composition XX!V and XXV systems shows acceptable cobb value of 19.2 and 20.5 $g/m^2$.

It can be seen in **Fig.1** that the brightness increases with increase in filler content which is normal (17). Hand sheets with neutral sizing possess ~2% El higher brightness than that in acid sizing.

| Table-6 | | |
|---|---|---|
| **Drainage and cobb values of sizes (CHD-AS)** | | |
| **Composition** | **Drainage time (sec)** | **Cobb value ($g/m^2$)** |
| XIII | 6.90 | 21.2 |
| XIV | 7.91 | 21.5 |
| XV | 7.04 | 23.3 |
| XVI | 7.43 | 19.6 |
| XVII | 7.22 | 20.4 |
| XVIII | 8.22 | 18.7 |
| XIX | 10.50 | 19.8 |

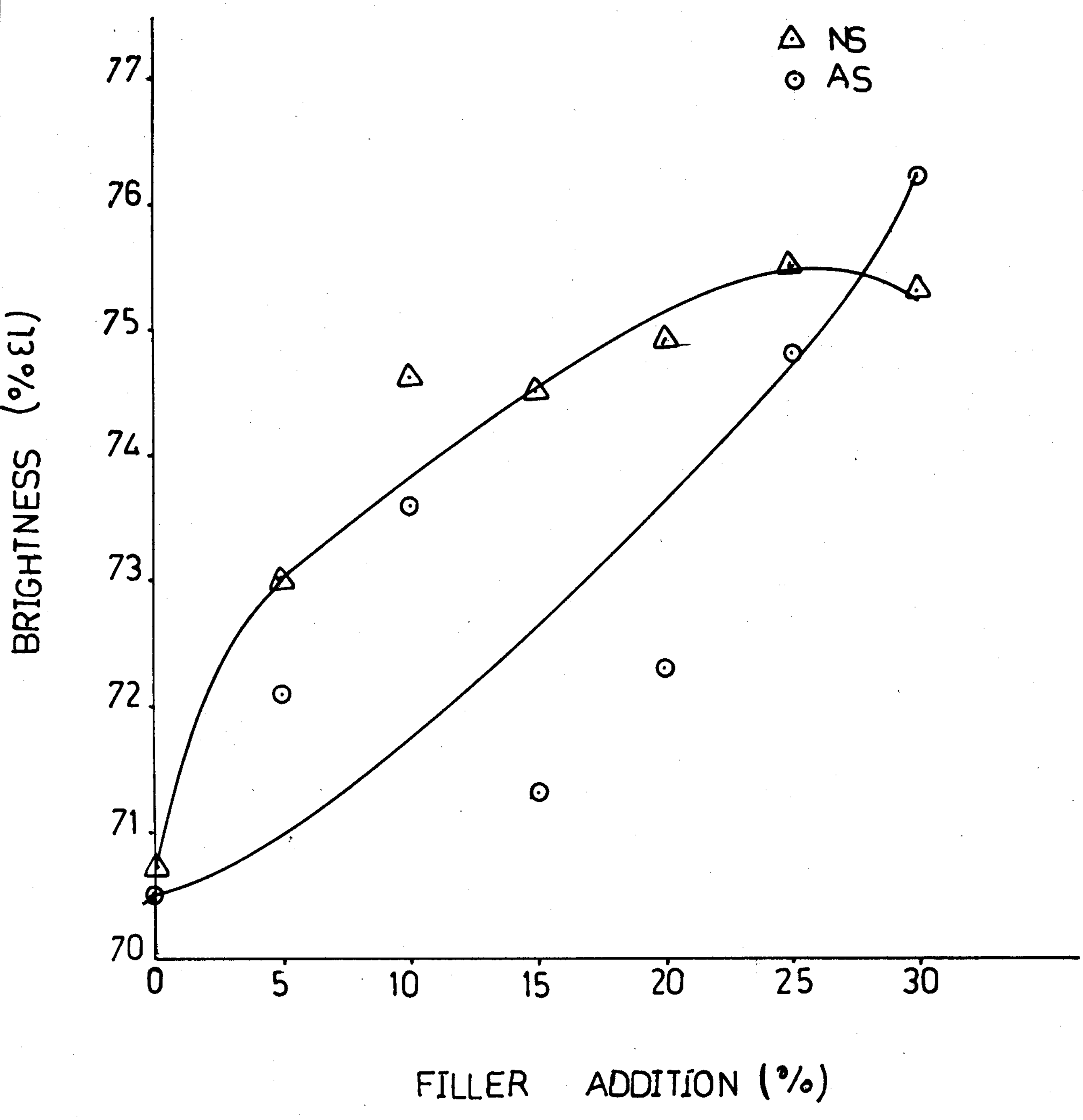



**Fig.1: Brightness in neutral and acid sizing.**

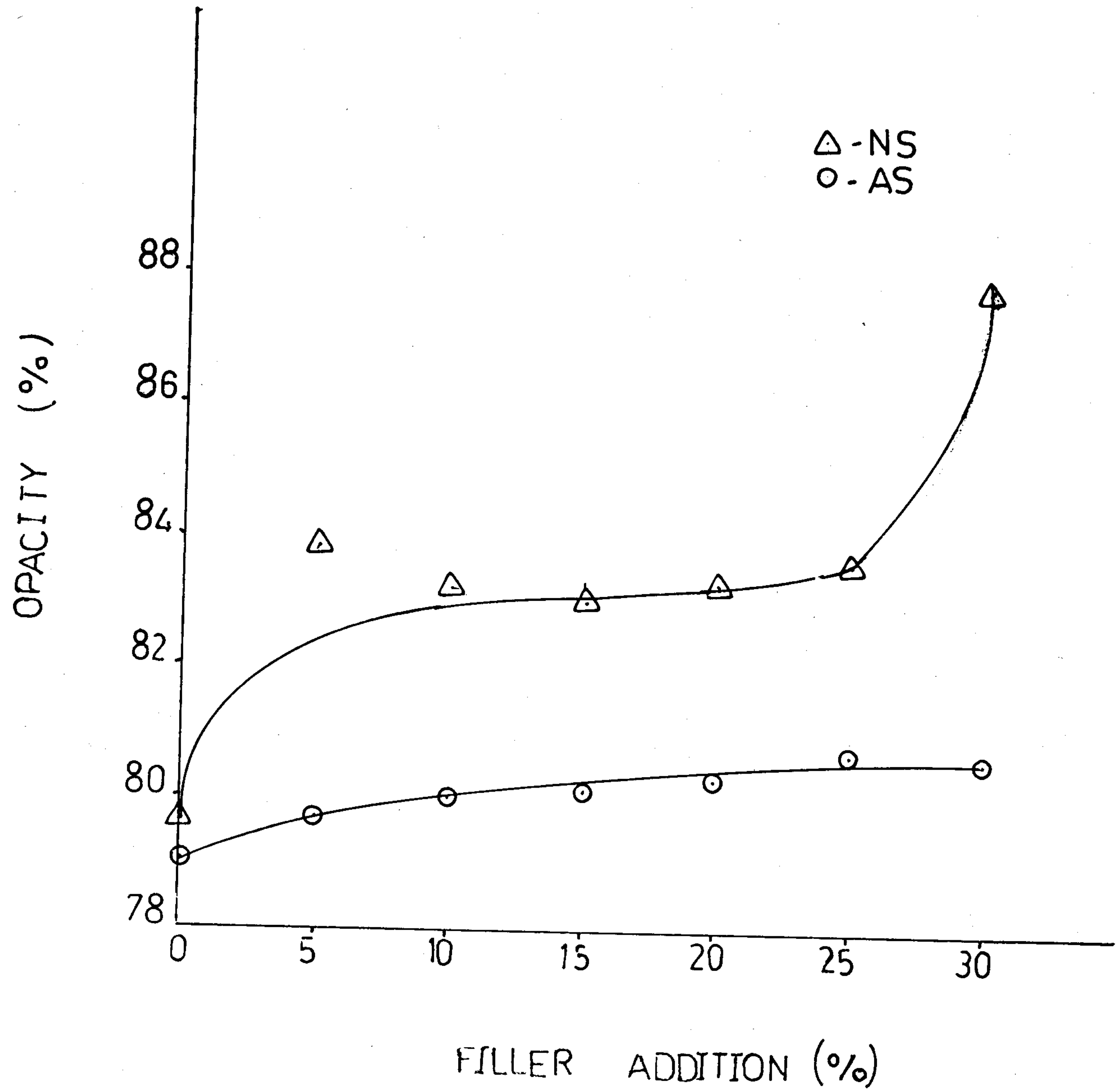
| Table-7 | | | | | |
|---|---|---|---|---|---|
| Compositions of sizes (CHD-NS) | | | | | |
| **Composition** | **Rosin (%)** | **Alum (%)** | **NSP (%)** | **Filler (%)** | **pH** |
| XX | 1 | 5 | 3.75 | - | 6.89 |
| XXI | 1 | 5 | 3.75 | 5 | 6.72 |
| XXII | 1 | 5 | 3.75 | 10 | 6.85 |
| XXIII | 1 | 5 | 3.75 | 15 | 7.06 |
| XXIV | 1 | 5 | 3.75 | 20 | 7.03 |
| XXV | 1 | 5 | 3.75 | 25 | 7.13 |
| XXVI | 1 | 5 | 3.75 | 30 | 7.34 |

In fact, at 15 and 20% addition levels, the difference is more than 3 degree. Thus brightness gain of 2-3% can be obtained on shifting to neutral sizing from acid sizing. However, at higher addition level, i.e. 30% (Fig.1), brightness in acid sizing surpasses that in neutral sizing. According to **Fig.2,** >3% higher opacity is achievable in neutral sizing than in acid sizing which is quite significant. Contrary to the brightness difference, at 30% addition level, on neutral sizing ~7% increase in opacity has been observed. The opacity values correspond to the scattering co-efficient values (18) plotted in **Fig.3.** It is well known that scattering coefficient increase with increase in filler addition level. Higher filler level increases the particle air surface area and thus the light can scatter better. This is true both in acid as well as neutral sizing. **Fig.4** shows that the ash contents in hand sheets have increased with filler addition level, supporting to the light scattering phenomena. For the same level of filler addition, ash content in neutral sizing is higher than in acid sizing. 2-3% higher ash content has been observed in the former. The neutral pH thus accelerate filler adsorption more preferentially inside the fibre lumens than in neutral sizing. As in neutral sizing, the surface carries lower level of charges, compared to acid sizing, adsorption of talc becomes more easy than in acid sizing resulting in higher ash content in the former. The % retention in neutral sizing is again higher than in acid sizing **(Fig.5).** Above 20% however, in both the cases the filler retention decreases and thus above 25%, addition of filler retention aid may be required.

The alum consumption can be reduced on using calcium carbonate, namely from 5% to 3%. 1% of neutral sizing product has been taken with GCC and a brightness value of 75% El was achieved, the cobb value being 27.7 $g/m^2$. Our preliminary results indicate that the present process of neutral sizing is more cost effective than the commercially available neutral sizing chemical. This work is intended to be elaborated in a subsequent paper.

| Table-8 | | |
|---|---|---|
| Drainage and cobb values of sizes (CHD-NS) | | |
| **Composition** | **Drainage time (sec)** | **Cobb value ($g/m^2$)** |
| XX | 9.98 | 20.8 |
| XXI | 8.85 | 27.62 |
| XXII | 9.07 | 27.68 |
| XXIII | 8.00 | 18.68 |
| XXIV | 8.43 | 19.16 |
| XXV | 8.54 | 20.53 |
| XXVI | 9.27 | Soaked |

**Fig.2: Opacity in neutral and acid sizing.**




## CONCLUSIONS

Neutral sizing exhibits superior properties over acid sizing, notably brightness (2-3% El), opacity (4-6%), scattering coefficient (2-3 $m^2/kg$) and filler retention (2%). The optimum filler addition level with talc, has been found to be $\leq$ 25 in neutral sizing at pH of 6.7 to 7. Both CEpHH and CEpHD pulps of bamboo-hard wood can be subjected to neutral sizing. Alum and rosin are to be used along with the neutral sizing product from sodium aluminate.


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Fig.3: Scattering coefficient in neutral and acid sizing.

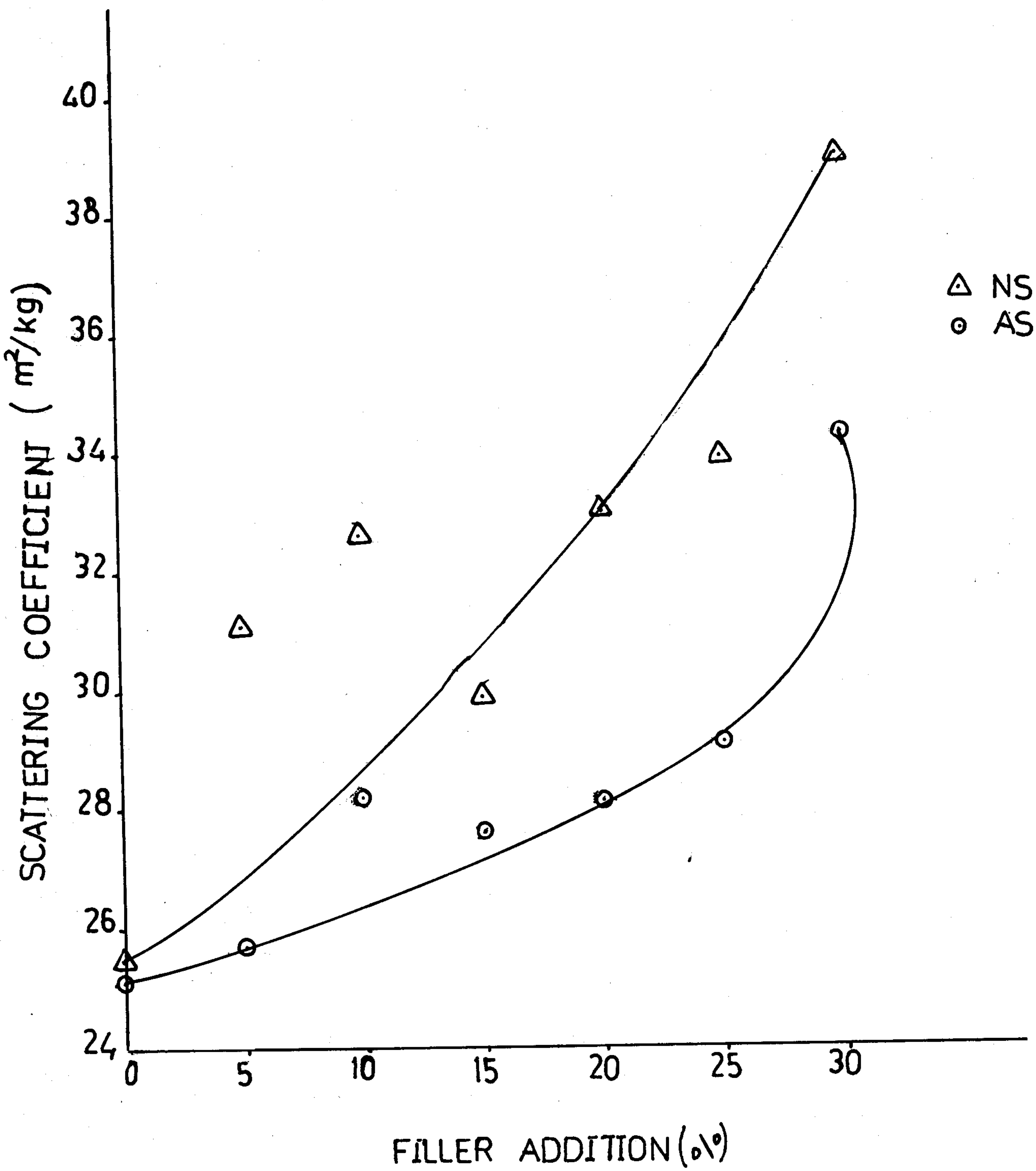


**Fig.4: Ash content in neutral and acid sizing.**

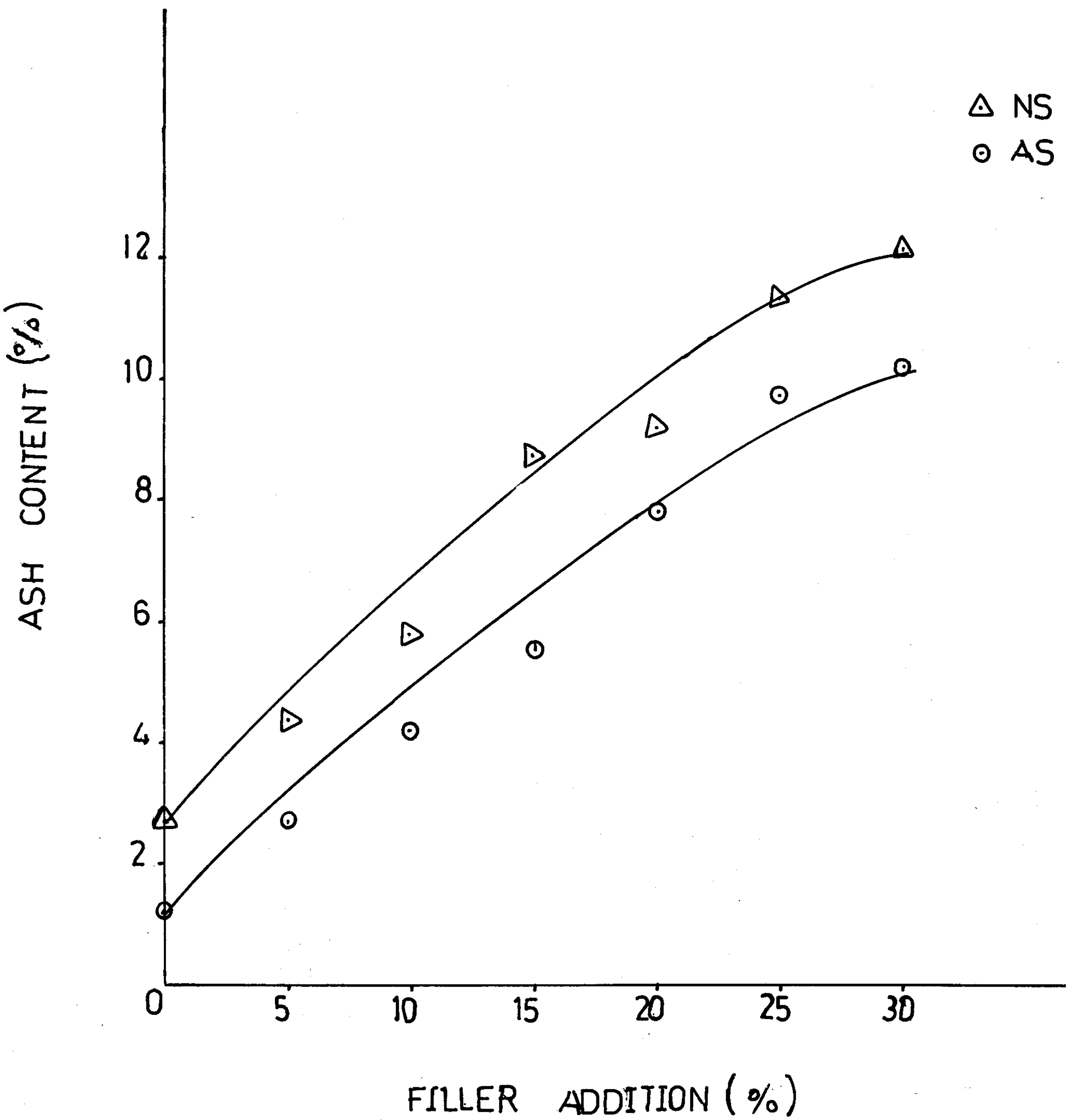
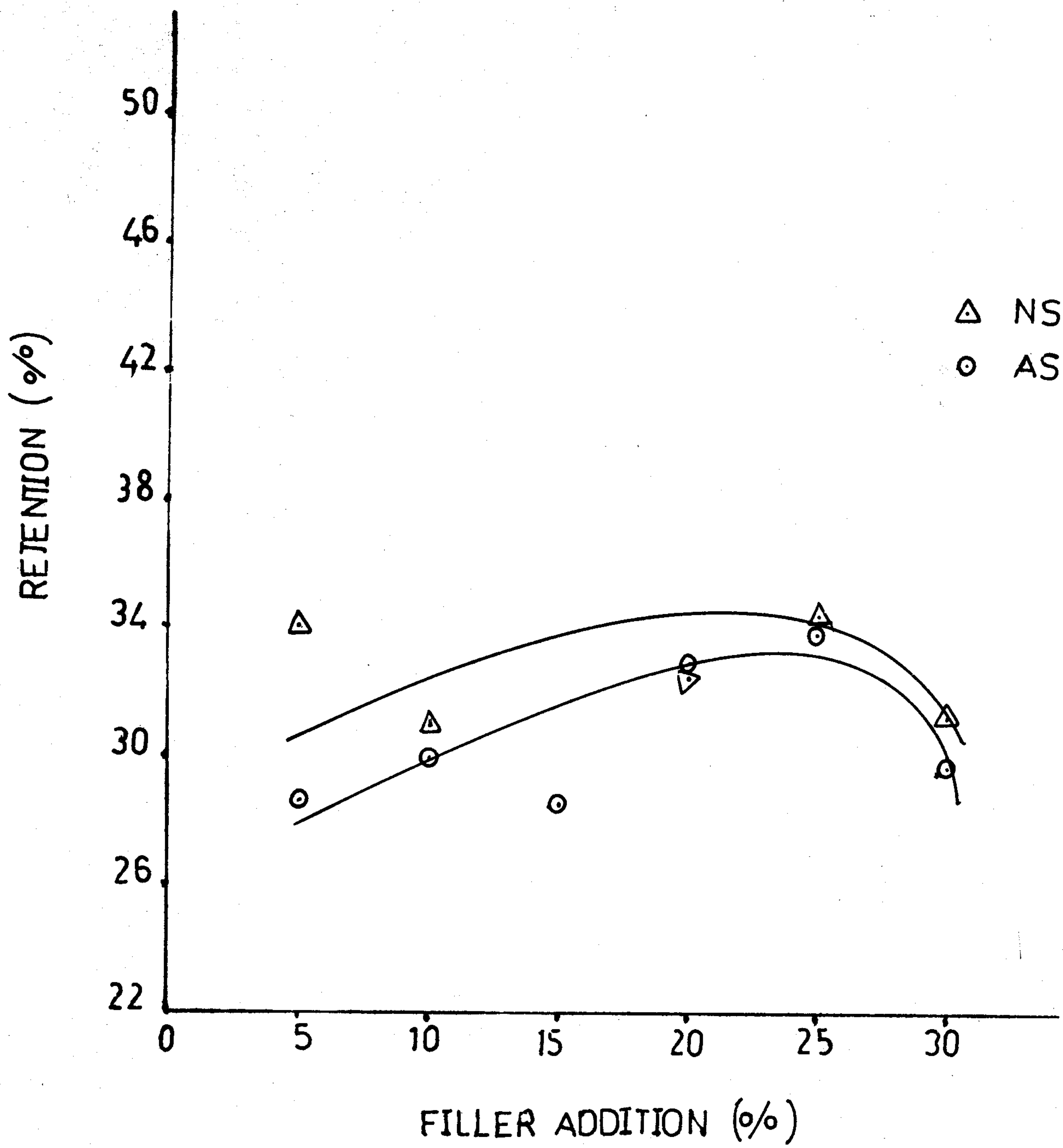


Fig.5: Retention in neutral and acid sizing.

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