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New Production Method for Nano Silica Sol and its Application for Papermaking

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Contents

1.Introduction

Colloidal silica has been used widely as a retention and drainage aid In papermaking industry.

But, Silica sol could be rarely used in papermaking and water treatment. Because silica sol has the following disadvantages.

1.Poor stability of their quality

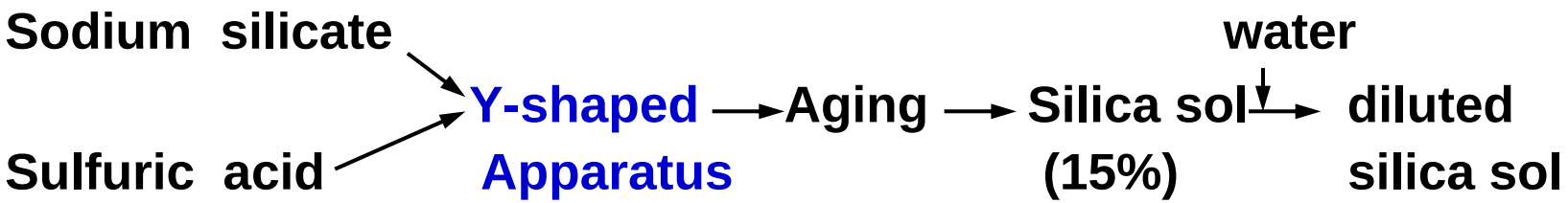
2.Low productivity of silica sol

We have developed the new production method of silica sol with particle size 3-5nm using Y-shaped apparatus and found that this silica sol may be used as a retention aid and a wastewater treatment agent for papermaking by controlling polymerization viscosity of sol.

We can easily produce high concentration silica sol of 15% SiO_2.

2. Production Method and properties of Silica Sol

a) Reaction



$$Na_2O \cdot 3SiO_2 + H_2SO_4 \longrightarrow 3SiO_2 + Na_2SO_4 + H_2O$$

b) Raw materials

Sodium Silicate liquid :28 ~29 (g/100ml)

($Na_2O \cdot 3SiO_2$) M.R 3.0 ~3.2

Sulfuric acid :20 ~22 (g/100ml)

c) Reaction condition

Temp. : 30 ~40 ℃

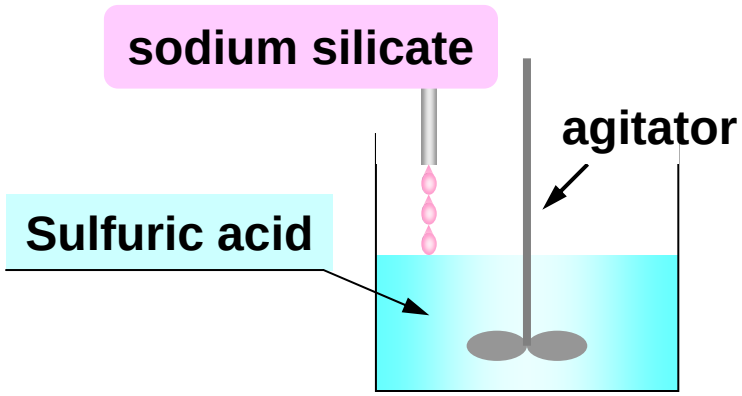
SiO_2 contents : 14 ~16 (g/100ml)

Aging Viscosity : 10 ~12 mPa·s

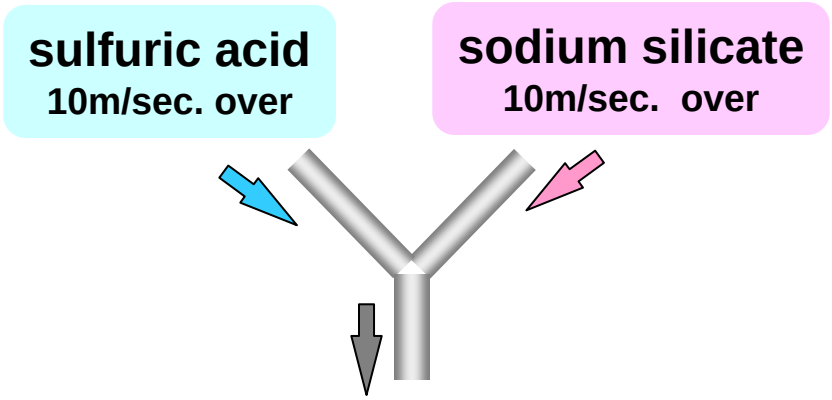
pH : 1.5 ~1.8

Figure 1 Production method of Silica sol by using Y-shaped Apparatus

Item		Conventional	New
Reactor		High Power agitator	Y-shaped apparatus
Heater		Use	No use
SiO_2 concentration	(%)	6 Max	14 ~ 16
Reaction time	(min.)	60	at moment
Reaction Temp.	(℃)	65	30 ~ 40
Aging time	(min.)	140	90 ~120



Silica sol 6%



Silica sol 14 ~16%

Productivity: 5 ~10 times

Figure 2 Comparisons Between conventional and New Production methods

Figure.3 Reaction part of Y-shaped apparatus

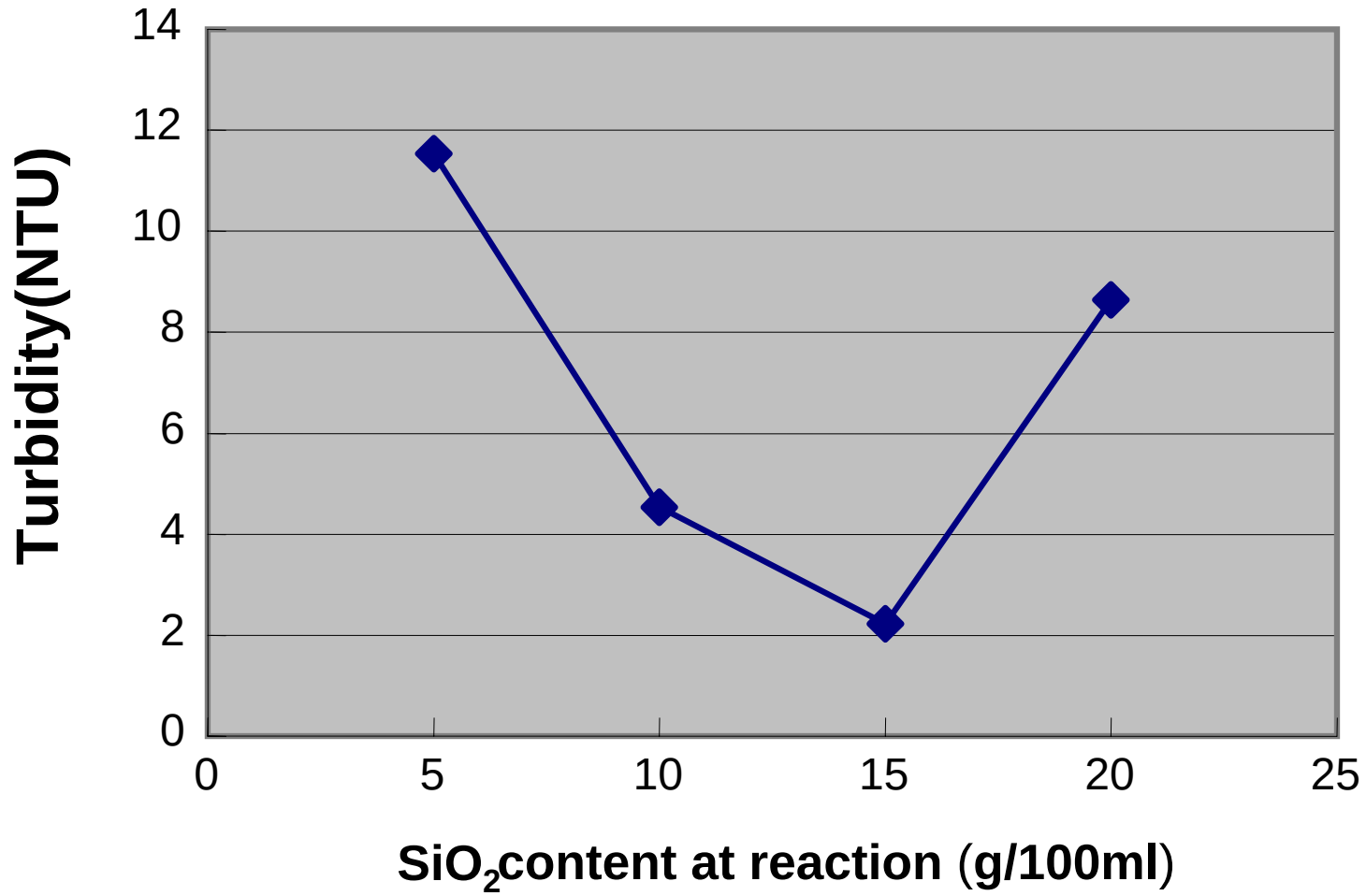


Fig.4 Relationship between SiO_2 contents and effect of coagulation

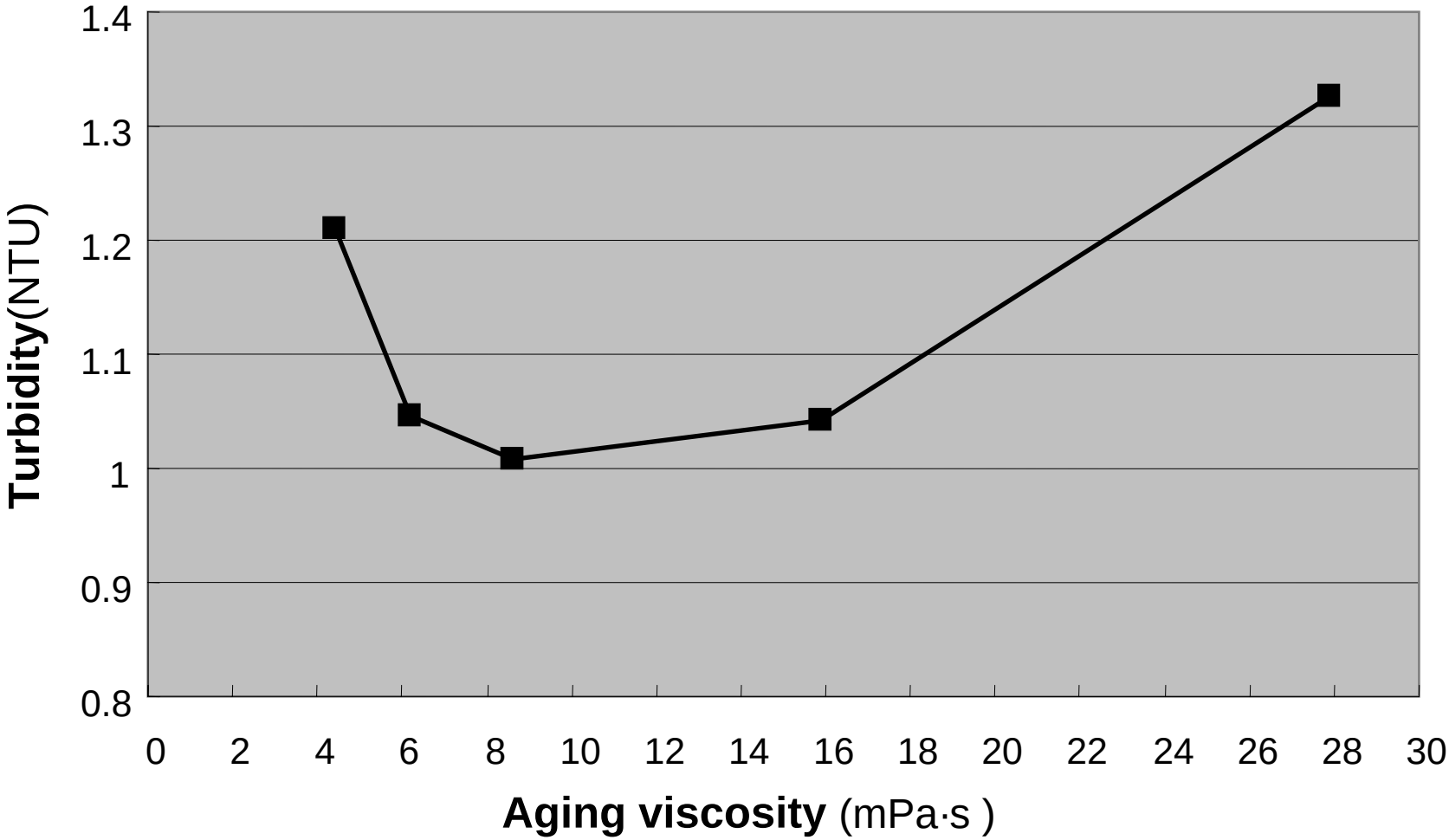
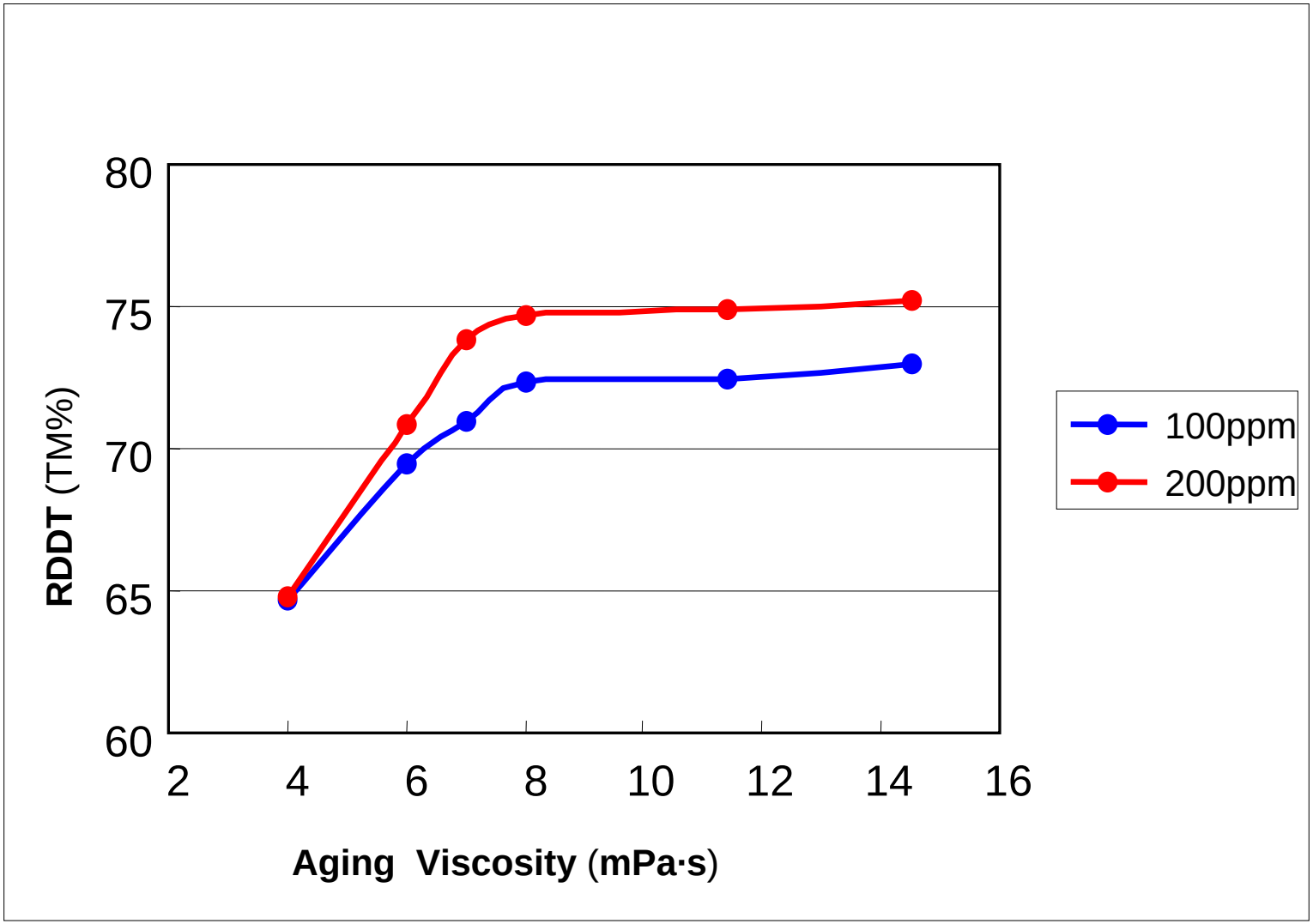


Fig.5 Relationship between aging viscosity and effect of coagulation in raw water



RDDT: Light transmittance of white water (filtrate by 100 mesh)

Fig.6 Relationship between Aging Viscosity and effect of retention

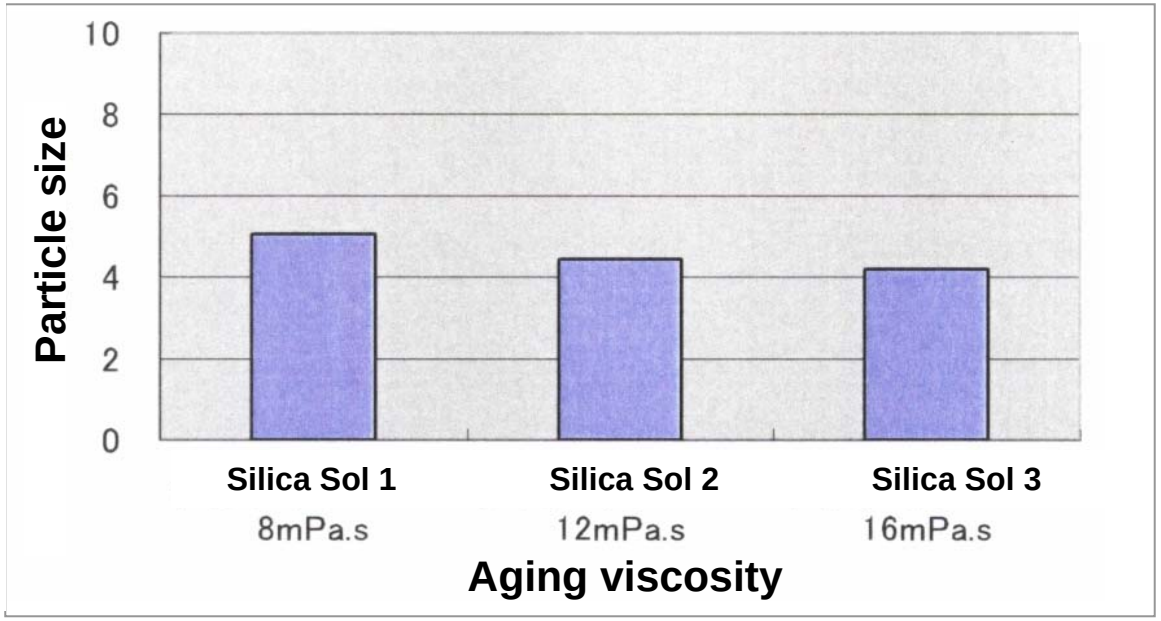


Fig.7 Particle size of silica sol by Dynamic Light Scattering

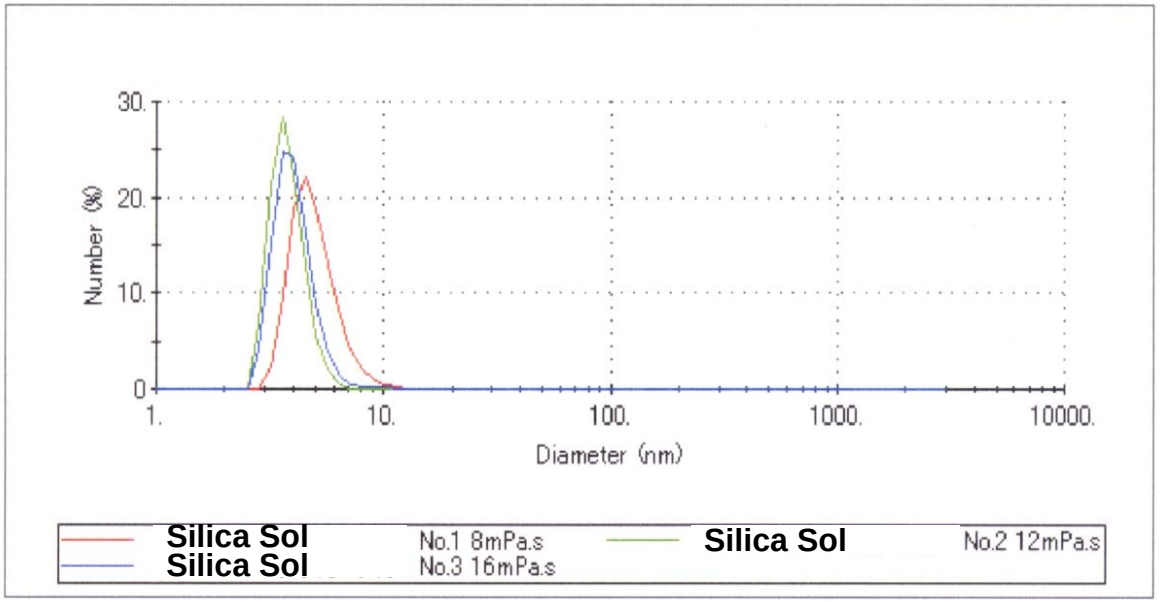


Fig.8 Particle size distribution by number

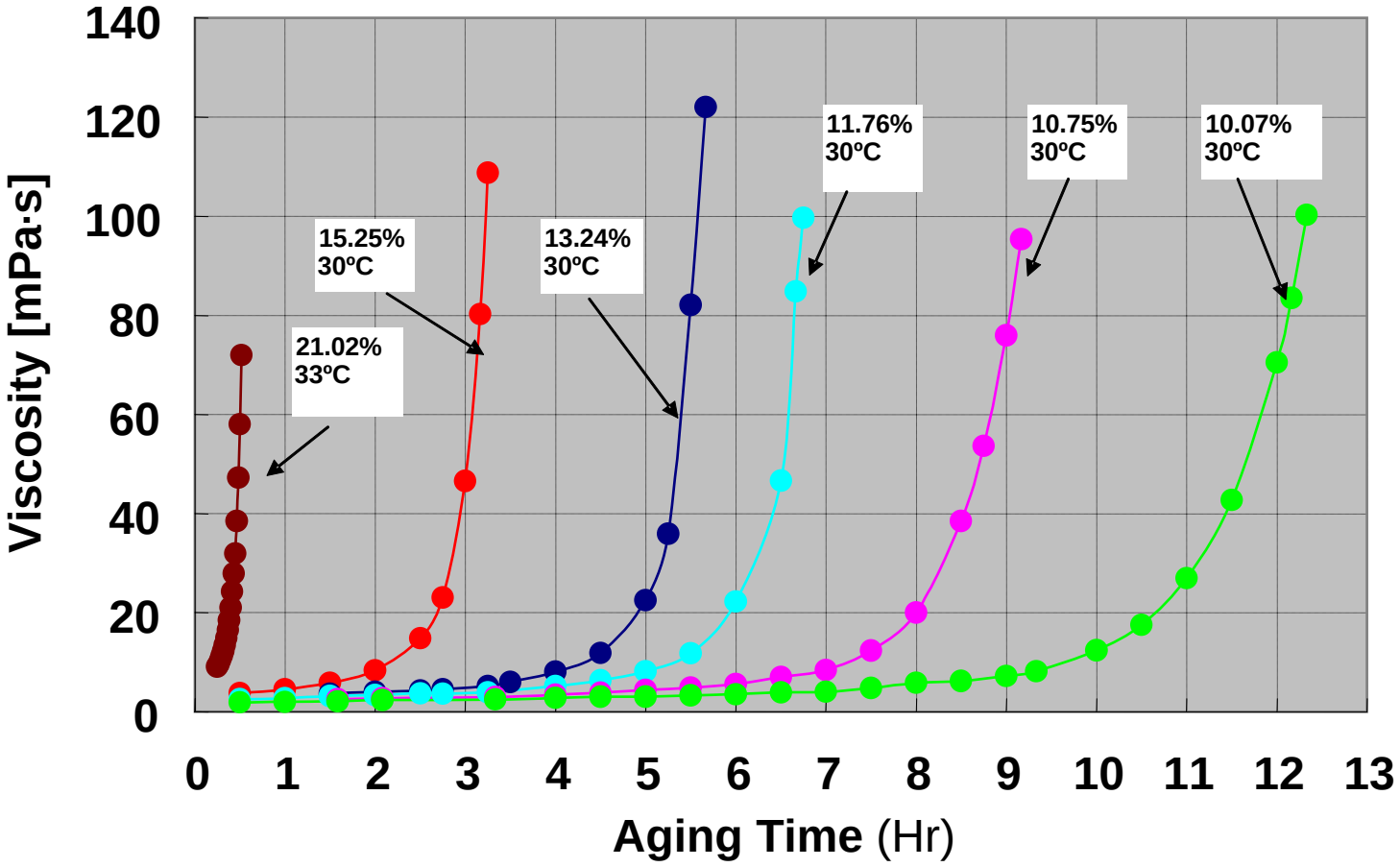


Figure 9 Characteristic of Viscosity as Function of SiO_2 Concentration and Aging Time (at reaction step)

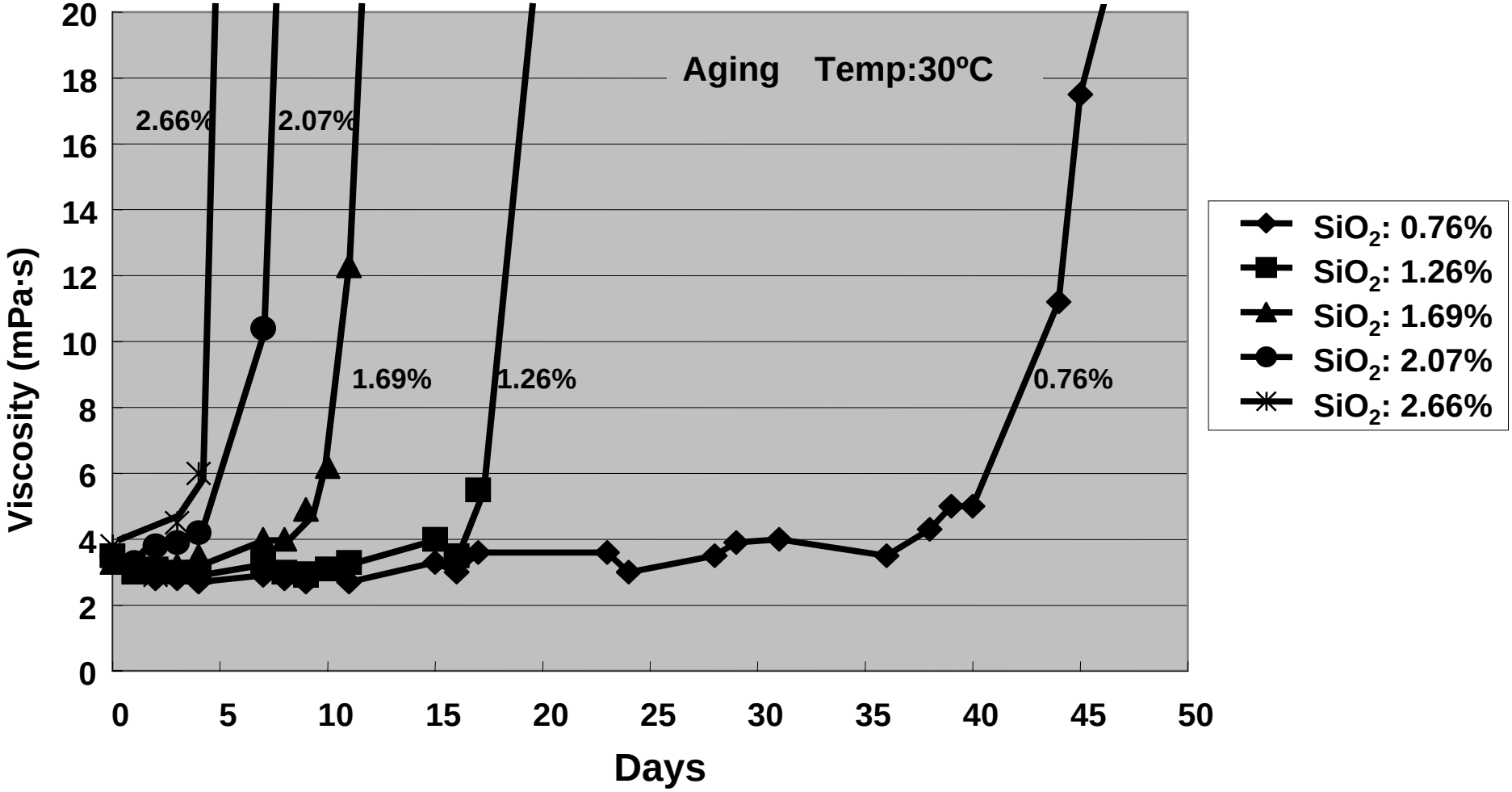


Fig.10 Stability of a diluted Silica sol

3. Application of Silica Sol

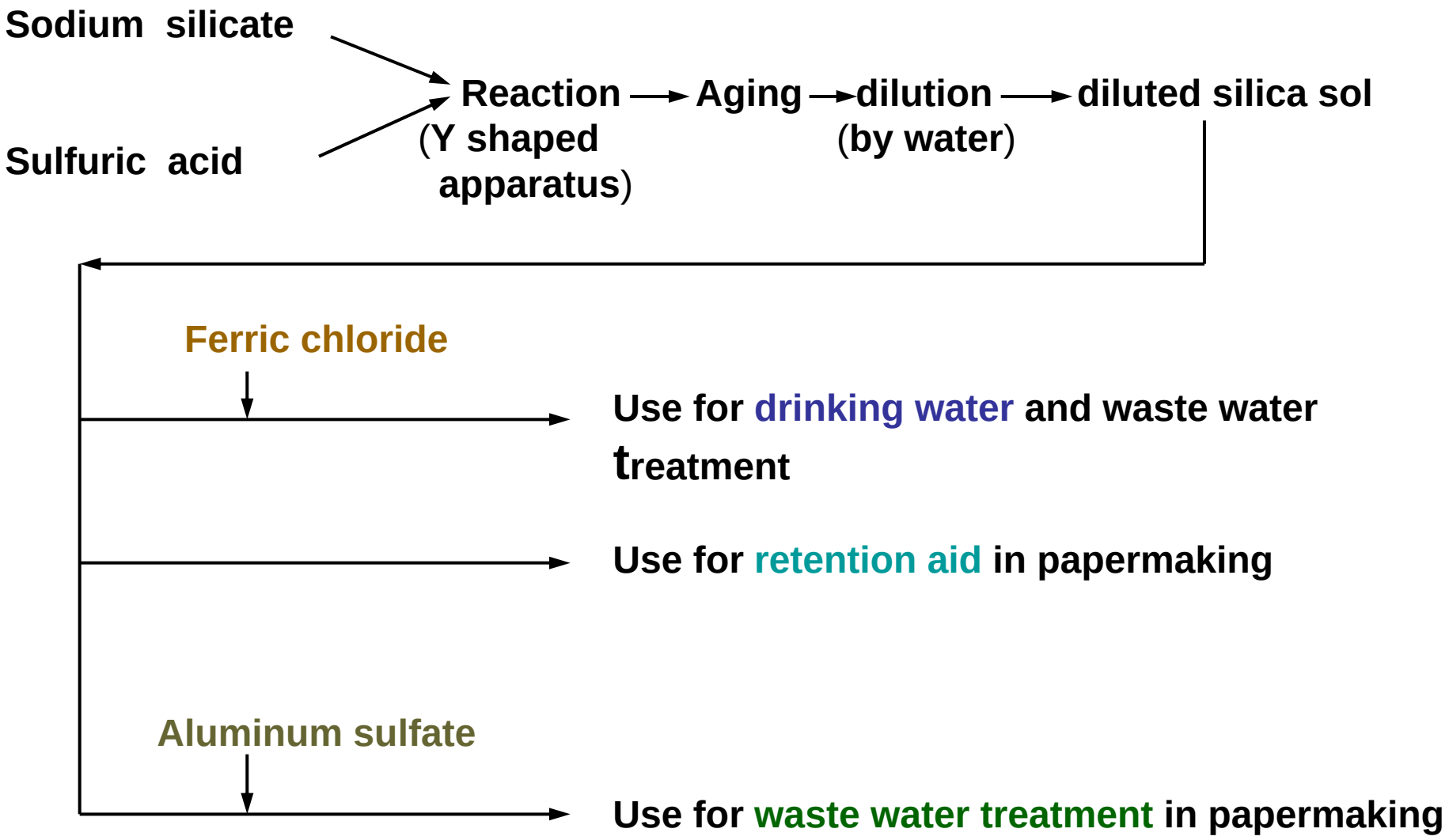
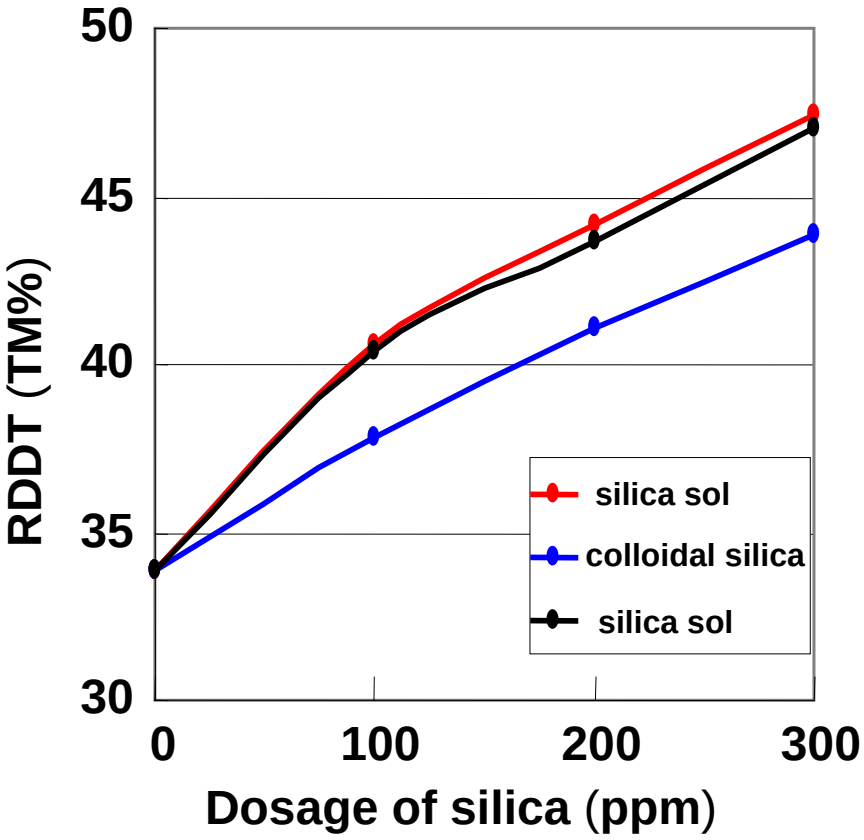


Figure 11 Application of silica sol.



RDDT: Light transmittance of white water (filtrate by 100mesh wire)

Fig.12 Evaluation of Retention Aid in Laboratory (Retention)

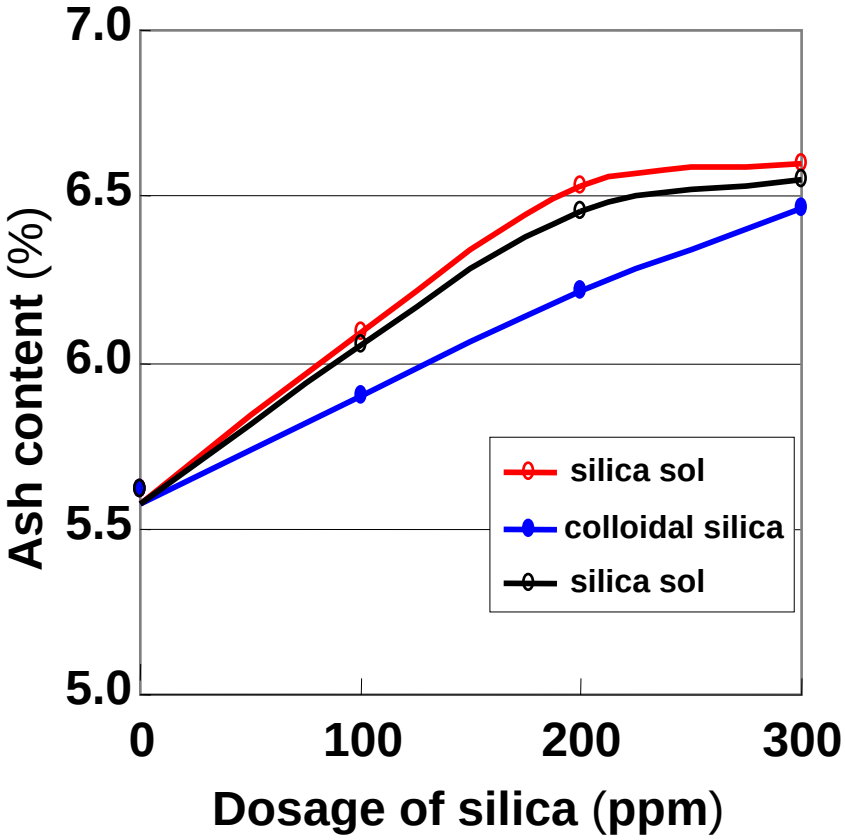


Fig.13 Evaluation Retention Aid in Laboratory (Ash retention)

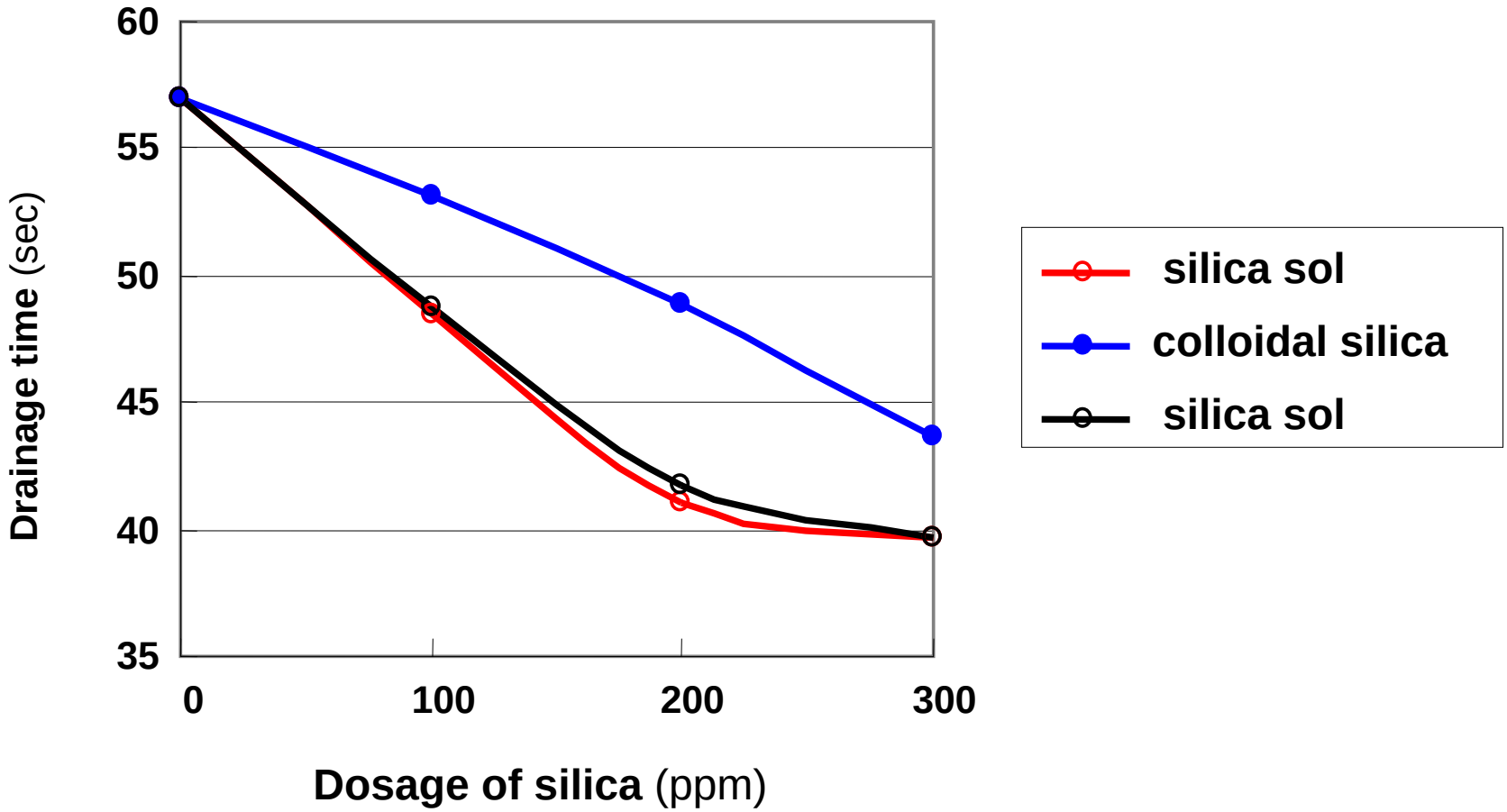


Fig.14 Evaluation Retention Aid in Laboratory (Drainage)

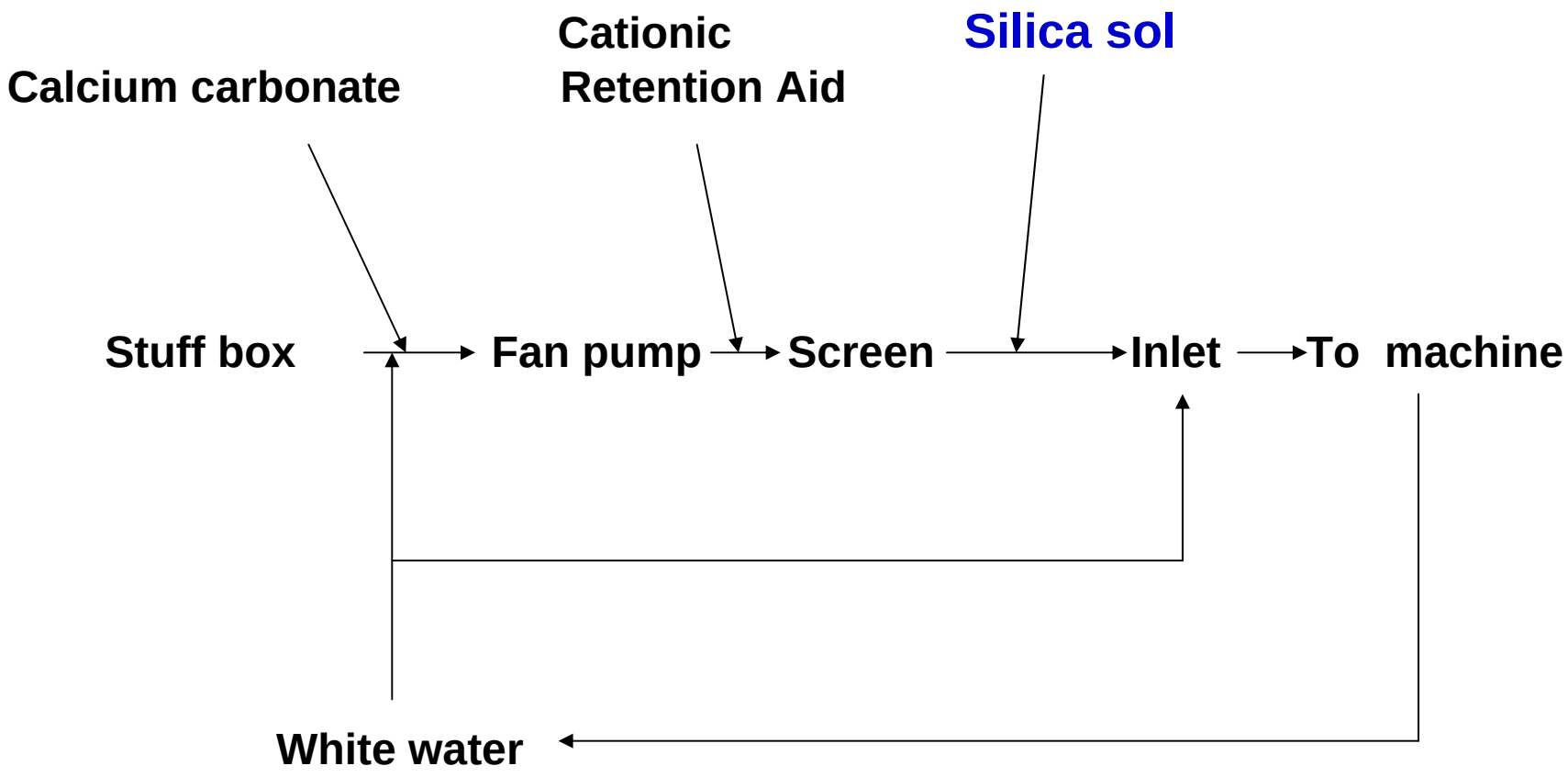


Fig.15 Simplified Flow Chart for the Mill Trial

Table 1. Condition of the Mill Trial and Results

1) Condition of the Mill Trial

Paper type	:	**PPC (neutral paper)**
Capacity	:	**240 tons/day**
Basis weight	:	**60 ~64 g/m^2**
Wire speed	:	**950 m/min.**

2) Results

Retention aid	**Silica sol**		**Colloidal Silica**
Dosing (ppm)	**200**	**180**	**200**
T-Retention rate (%)	**78.9**	**78.0**	**76.5**
Ash Retention rate (%)	**43.3**	**42.5**	**38.1**
Reduce 3K steam (%)			
(**Silica sol/colloidal silica**)	**17**	**15**	**1**

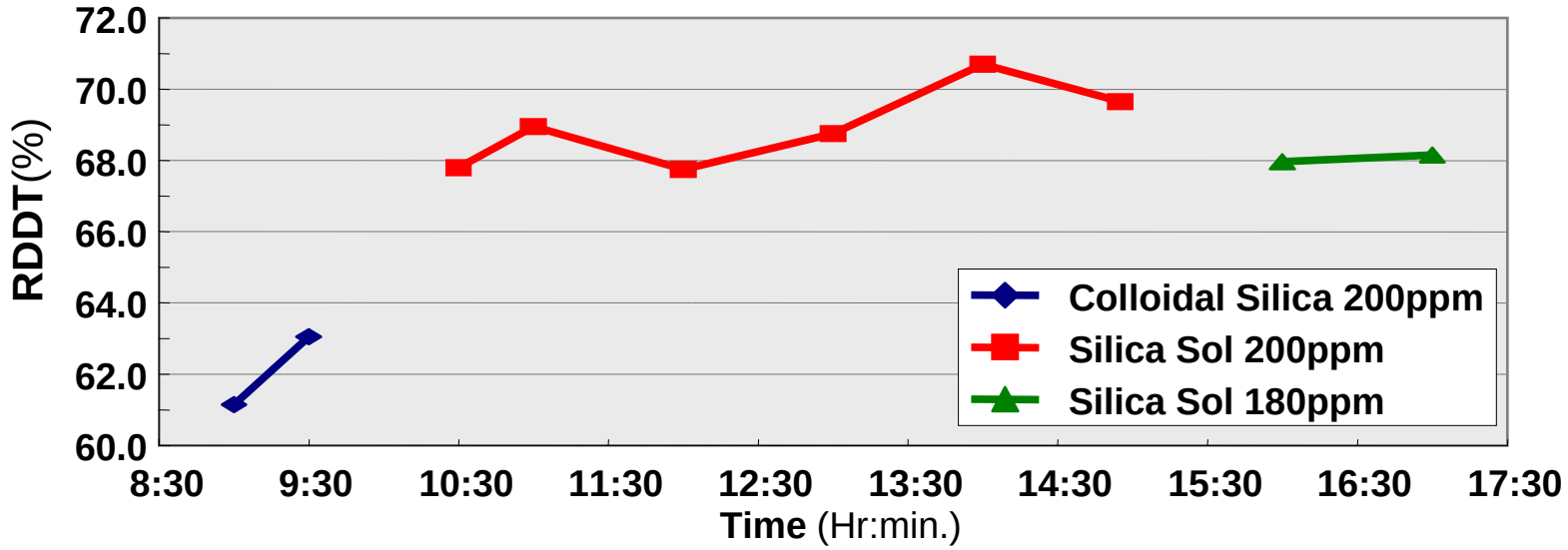


Fig.16 Retention Effect at the Mill Trial

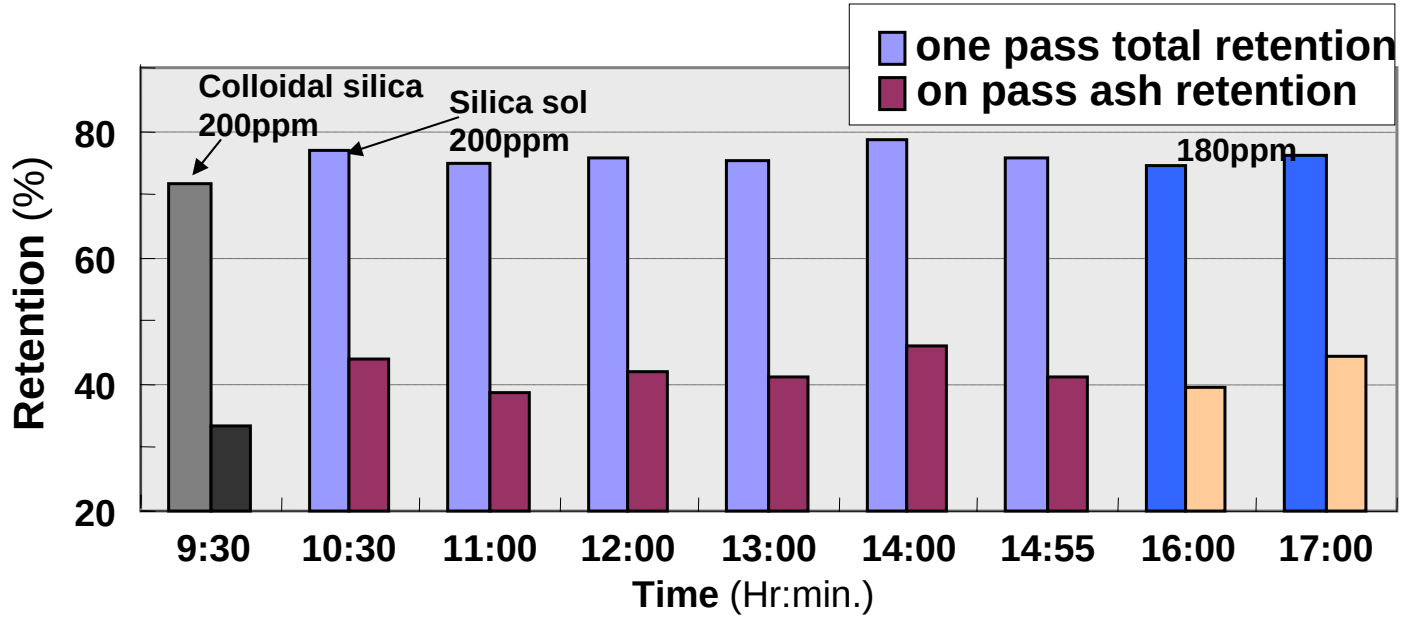


Fig.17 One pass total and ash retention at the Mill Trial

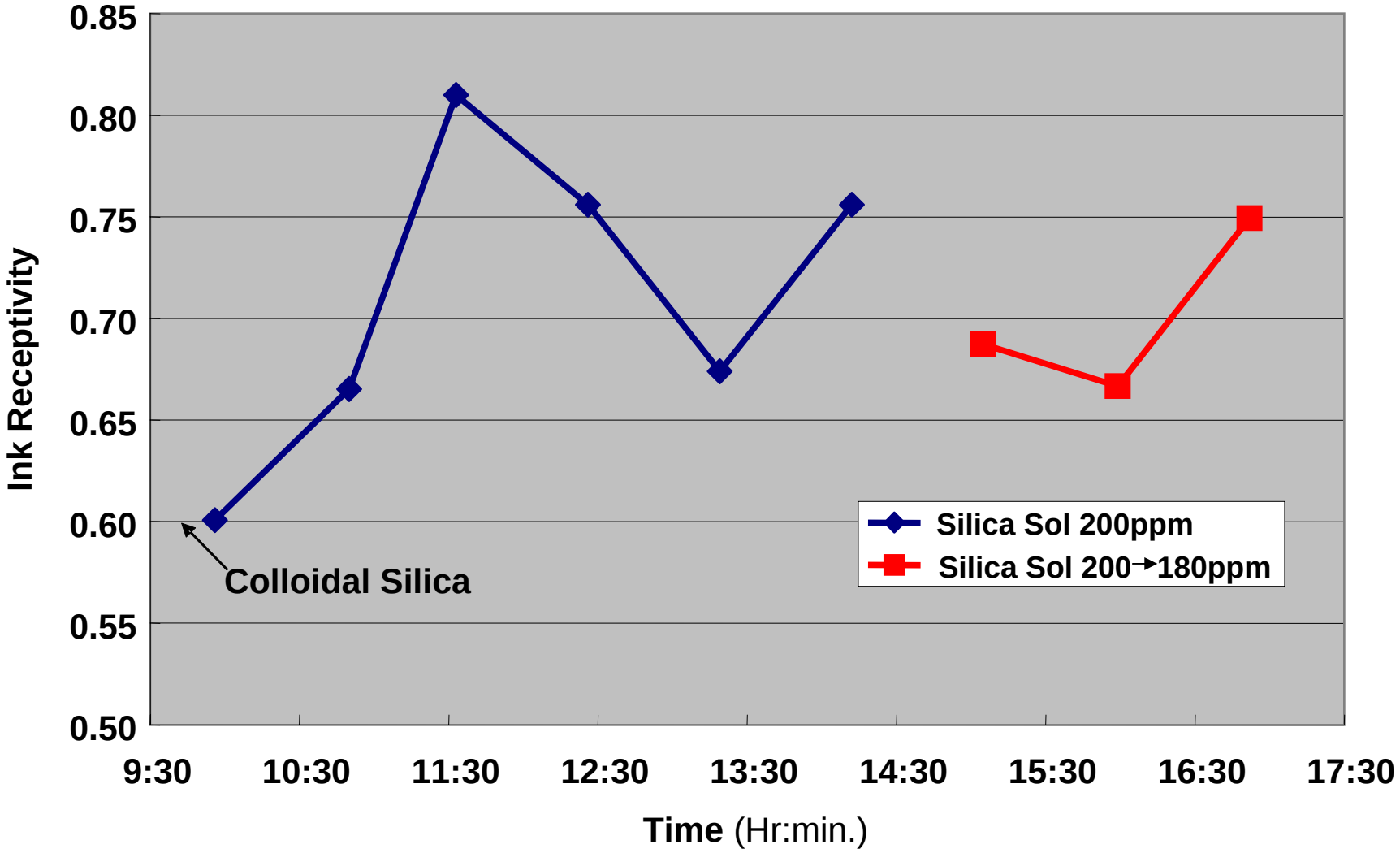
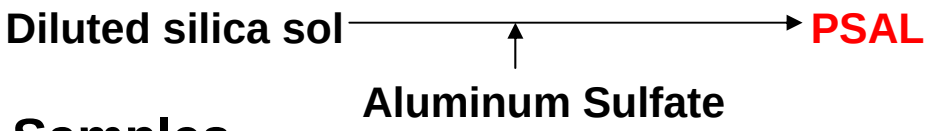


Fig.18 Ink Receptivity of paper at the Mill Trial

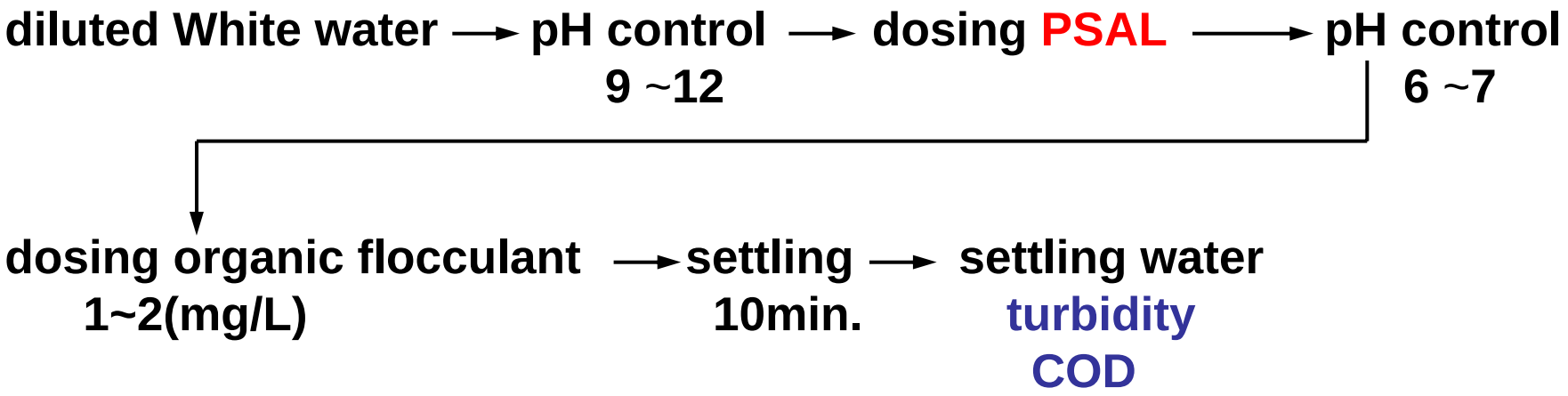
Table 2. Application to paper waste water



1. Samples

Sample	Turbidity	COD	pH
Raw White water	1300 ~1500		6.7
diluted White water (1)	93 ~ 100	97	6.2 ~7.2
diluted White water (2)	420 ~ 434	407	6.6 ~7.2

2. Treatment method



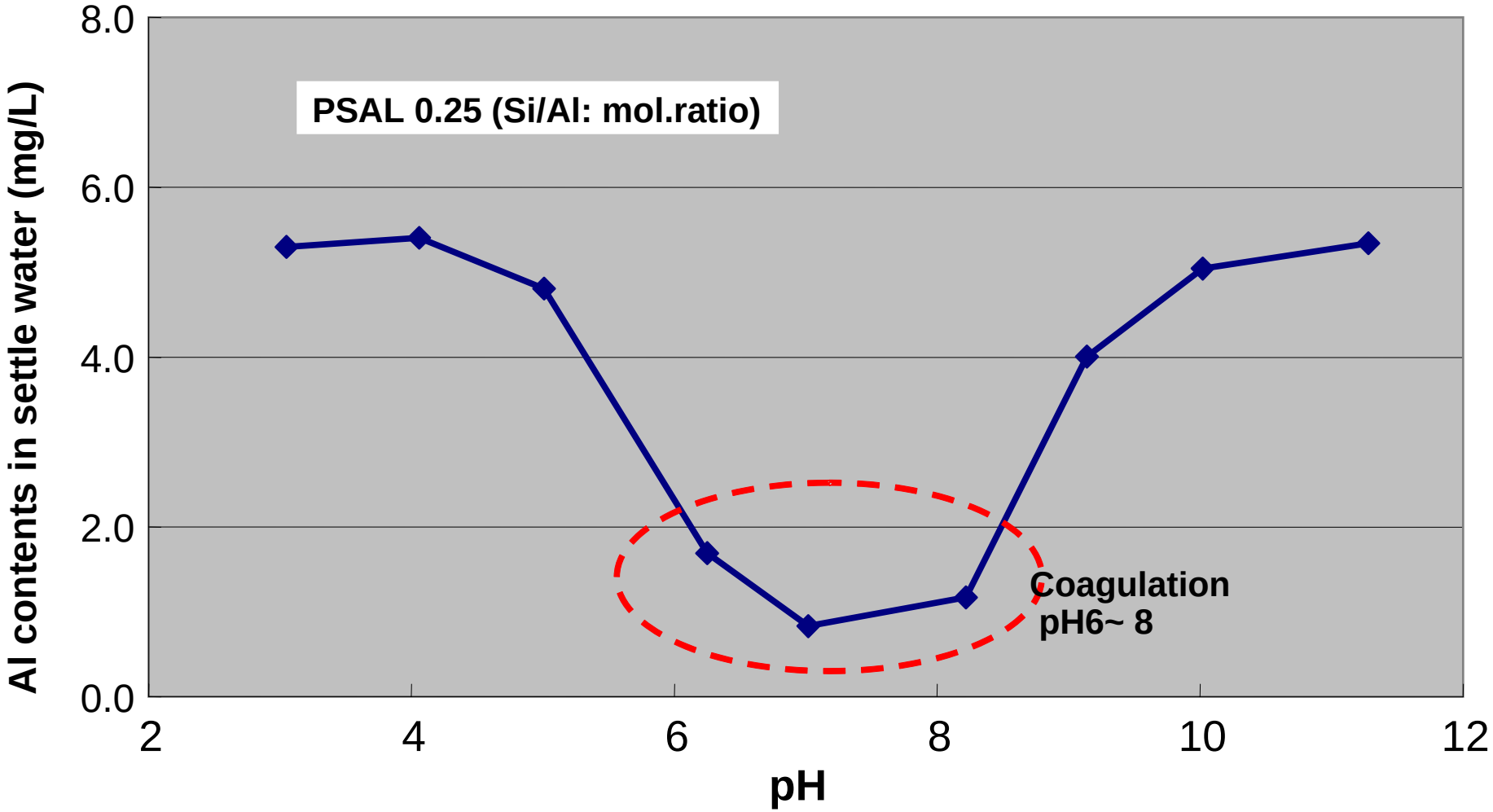


Fig.19 coagulation property of Polysilicate Aluminum (PSAL)

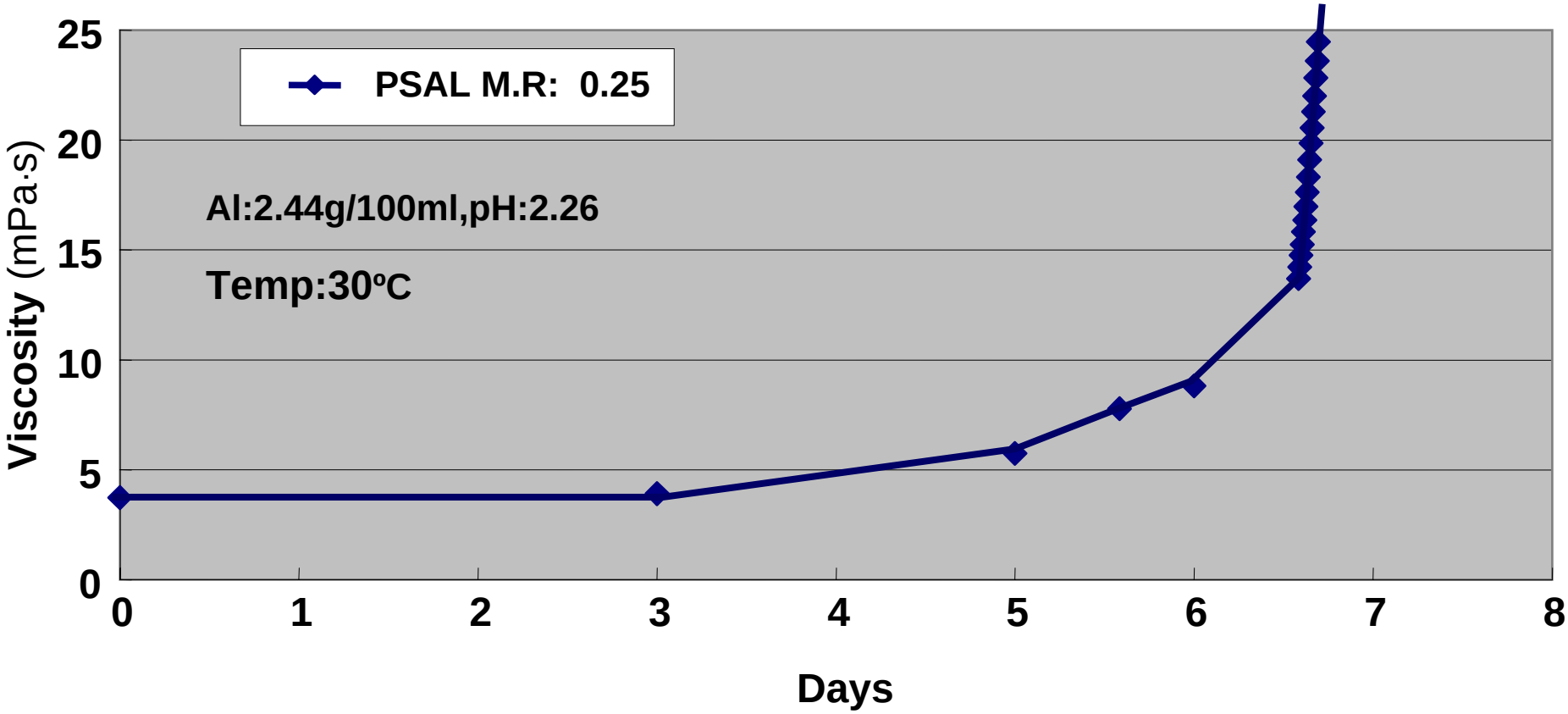


Fig.20 stability of storage of Polysilicate Aluminum

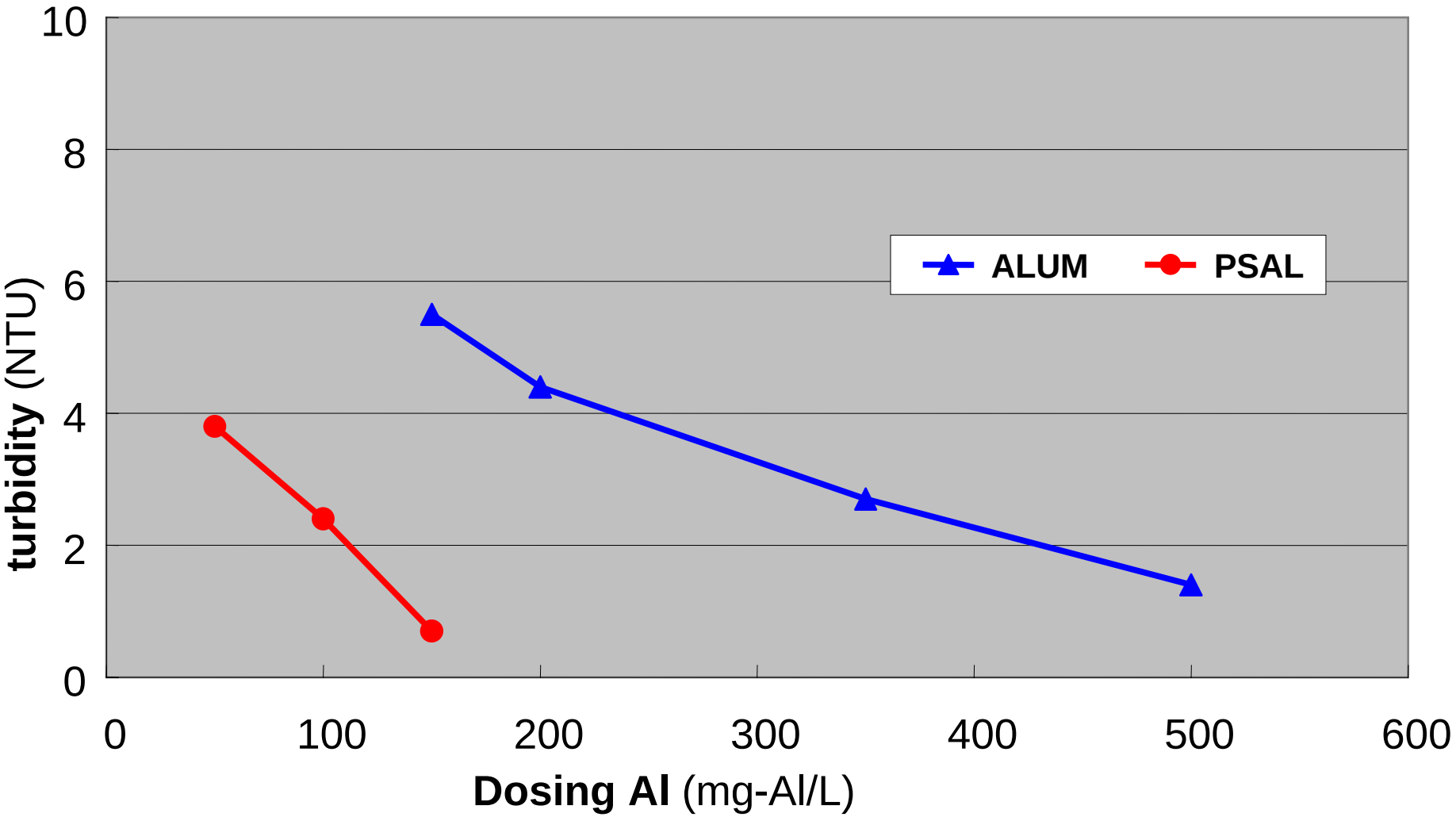


Fig.21 Comparison between ALUM and PSAL coagulant

(at the diluted White Water (2) sample)

Table 3. Results for white Water Treatment

1.Turbidity

Sample	PSAL-0.25 (mg-Al/L)	organic flocculant (mg/L)	Turbidity (NTU)	
			Before	After
Dilute White Water(1)	5	1	98	1.2
Dilute White Water(2)	100	2	404	1.3

2.COD

Sample	PSAL-0.25 (mg-Al/L)	organic flocculant (mg/L)	COD (mg/L)		cut. rate (%)
			Before	After	
Dilute White Water(1)	5	1	97	22	77
Dilute White Water(2)	100	2	407	85	79

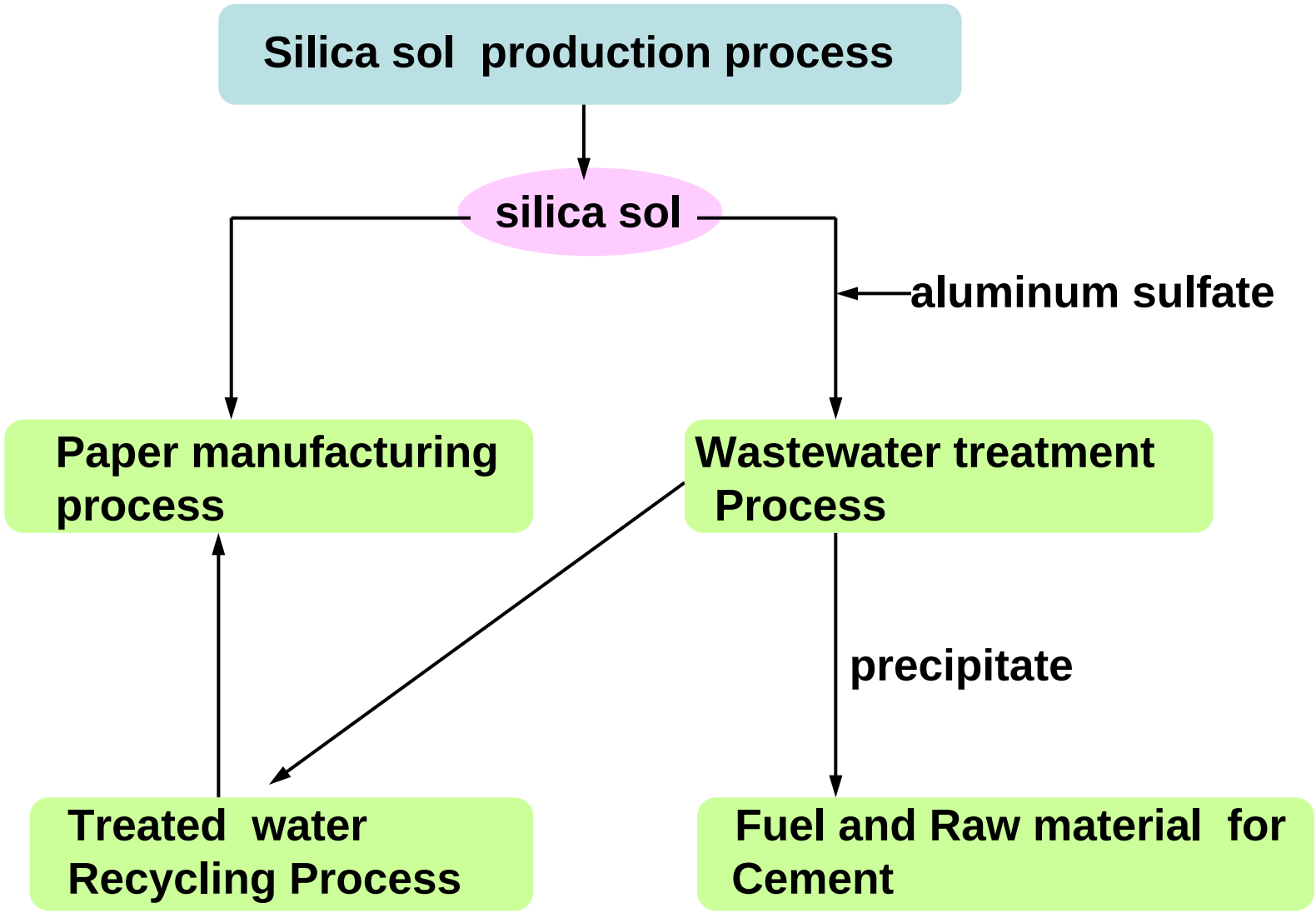


Fig.22 Application model for papermaking

4. Production Unit

Size:3600 x 1650 x H2250
Aging Tank :300L (42kg-SiO_2/batch)

Fig.23 Demonstration unit

5.Conclusion

Silica sol by the new method can be used as a retention aid and a waste water treatment agent for papermaking by controlling polymerization viscosity of sol. It has the following advantages.

1. High productivity (15% SiO_2)

2. Good stability of quality and better retention and drainage effect for a neutral PPC grade.

3. Better Ink receptivity for paper than colloidal silica.

4. Very simple production unit and cost effective process.

5. Decrease in energy cost and solution of some environmental issues.

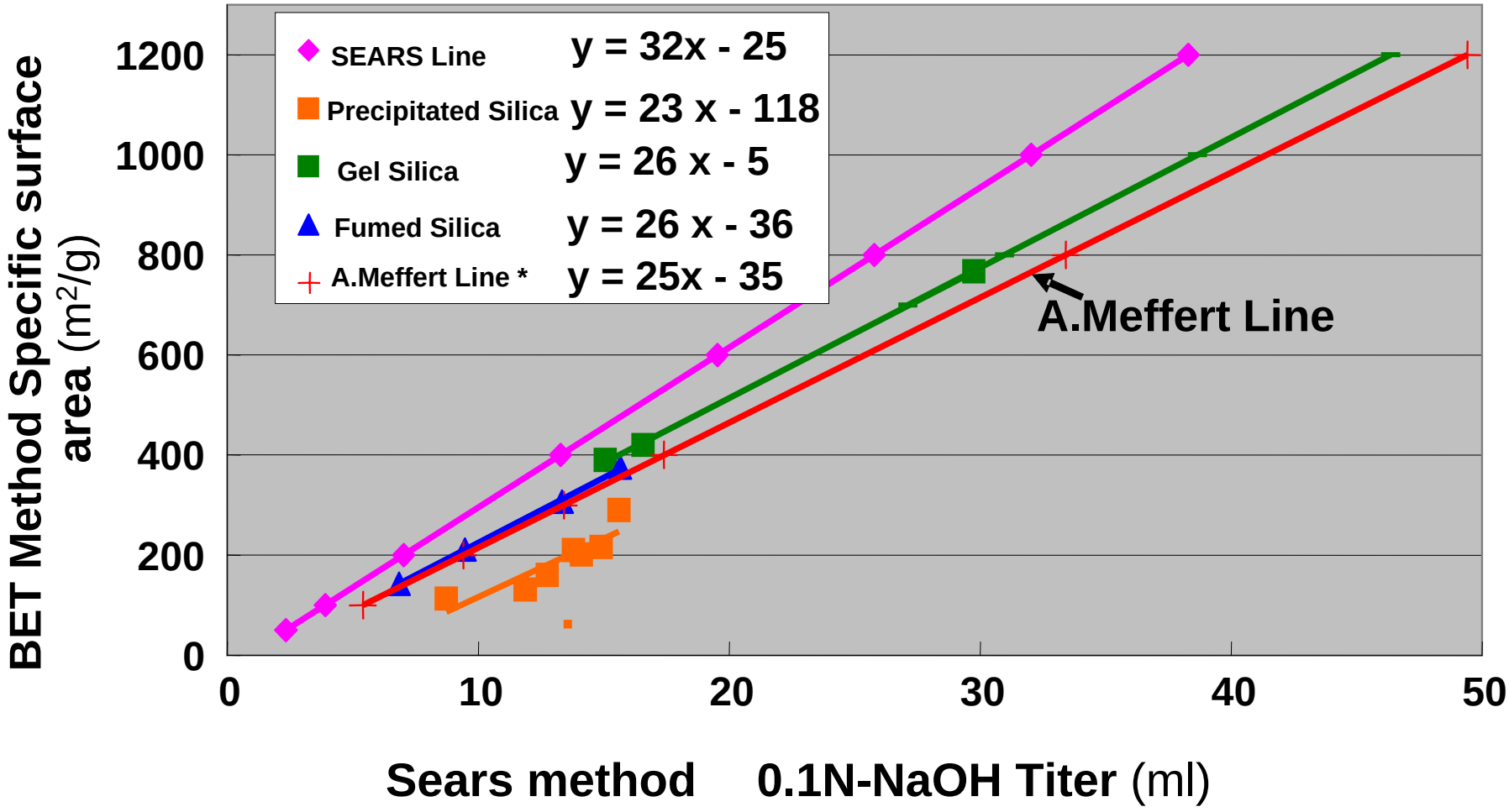
We hope that our technology can contribute to a paper company.

END

Thank you for audience.

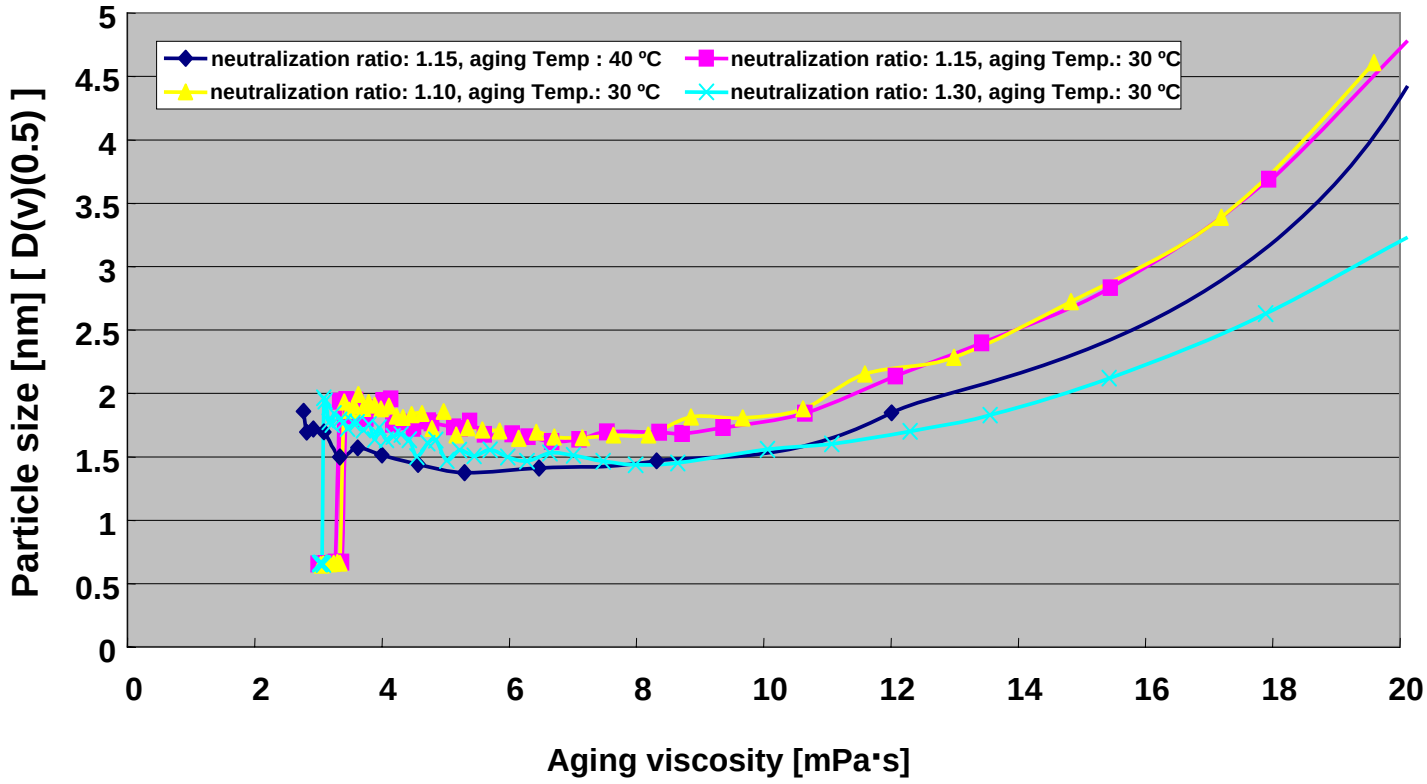
Others

Calibration Curve of BET Surface Area and Sears Titer



*:Z.Anal.Chem.249,231-233(1970)

Calibration curve varies with the production method of Silica



Relationship between aging viscosity and particle size of silica sol

Particle size start to change from about 10 of aging viscosity .