

Optimization of Alkaline Sizing to Reduce Sizing Cost

CESS Sponsored

Implementing Agencies:

ACIRD, Yamuna Nagar

CPPRI, Saharanpur

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Budget (Rs. in Lacs)

Project Budget : 38.4

CESS Contribution : 25.9 (20.9 - ACIRD, 5.0 - CPPRI)

ACIRD Contribution: 12.5

Time Frame: 18 months (Nov. 2010 to April 2012)

Background

- The purpose of sizing is to reduce the surface energy of cellulose so that its absorbency is reduced.
- $Cobb_{60}$ and contact angle measure the hydrophobicity of paper.
- The driving forces for conversion from acid/ neutral to alkaline conditions are:
 - Difficulty in using calcium carbonate as filler in acid papermaking
 - Corrosion in equipment and pipelines
 - Ageing effect in sized papers
 - Reduced brightness and high cost of sizing
- Alkyl ketene dimer (AKD) and alkenyl succinic anhydride (ASA) are cellulose-reactive chemicals used in alkaline conditions.
- AKD gives good sizing characteristics to paper but has some drawbacks such as being wax it causes slipperiness to the final sheet of paper. Slow reactivity of AKD can mean that the sheet is unsized by the time it reached the size press, so over-drying of the sheet is required to achieve some curing.

Background

- AKD has slow rate of hydrolysis as compared to ASA, so it is shipped as ready to use product in the form of emulsion to the paper mill.
- ASA emulsion is prepared on site just before use due to its high rate of hydrolysis.
- The hydrolysis of ASA emulsion is, somewhat, controlled with the efficient use of sizing agent at appropriate dose and dosing point. Overdosing of ASA causes the deposit problem on the wire part of machine and hence adversely affects the machine runnability.
- Optimized dosage of sizing chemicals also help in reducing the papermaking cost in addition to the cleaner system.
- It is thus required to optimize the dosage of sizing agents for all types of pulp furnishes used in India such as hardwood, agro-residues and recycled fibers with the utilization of commercial fillers (talc, GCC & PCC) and other wet-end chemicals.

Objectives

- **Optimization of chemicals for economical alkaline sizing**
 - **Development of methods to determine the retention of sizing agents in paper**
 - **Study the effect of various process parameters on alkaline sizing of agro, recycled and wood fibres**
 - **Development of greater and in-depth knowledge**

Salient Findings

Sizing behaviour of different pulp furnishes with different fillers using AKD sizing

- ❖ Among three different grades of GCC and two grades of PCC, GCC-1 and PCC-1 fillers were found more suitable with respect to the AKD requirement for achieving similar hydrophobicity in paper. →
- ❖ The dose of AKD with PCC filler to achieve similar hydrophobicity of paper was higher as compared with GCC and talc. →
- ❖ To achieve Cobb_{60} value of 30, the AKD dose required for hardwood and bagasse was comparable and higher than that for wheat straw and recycled pulp. It was the highest in case of mixed hardwood blended with bamboo. →
- ❖ The contact angle of paper made with hardwood and recycled furnishes was more than 100° even at Cobb_{60} value of 35 with all fillers while contact angles in case of agro residues were comparatively lower but stable at same Cobb_{60} value. →

Salient Findings

Sizing behaviour of different pulp furnishes with different fillers using AKD sizing

- ❖ To achieve Cobb_{60} value of 30 with GCC filler, the AKD dose required for hardwood and bagasse pulps was comparable, whereas, it was lower in case of wheat straw and recycled pulps.
- ❖ To achieve Cobb_{60} value of 30 with PCC, the AKD dose required for mixed hardwood pulps was comparable but the highest amongst five pulp furnishes.
- ❖ To achieve around 100° contact angle, the AKD dose required for mixed hardwood and bagasse pulp was comparable though it was slightly less for recycled pulp while this contact angle could not be achieved with wheat straw pulp.



Salient Findings

Sizing behaviour of different pulp furnishes with different fillers using ASA sizing

- ❖ Sizing properties were more stable using agro-residues as compared with hardwood pulps even at lower dose of ASA with all fillers. →
- ❖ The contact angle with hardwood and bagasse pulp was higher (101-105°) as compared with agro-residues even at $Cobb_{60}$ value of 40-45. →
- ❖ At $Cobb_{60}$ value of 30, the contact angle of wheat straw pulp was 96-98° with all the fillers. A marginal drop in contact angle was observed by increasing the $Cobb_{60}$ value from 30 to 40. →

Salient Findings

Sizing behaviour of different pulp furnishes with different fillers using ASA sizing

- ❖ The surface roughness of the handsheets prepared with agro-residues was lower than that of hardwood pulps which was one of the important parameters responsible for the lower values of contact angles in case of the former.
- ❖ The developed method for the determination of reacted and unreacted AKD in paper would help papermakers in controlling the dose of AKD.

Mill Trials

- ❖ Demonstrated the outcome of the project in two mills through plant scale trials which showed around 20% reduction in sizing chemicals (saving potential of Rs. 100/t of paper).
- ❖ In Mill-A and Mill-B, 700 and 500 tonne paper was produced, respectively during plant trial which was commercialised thereafter.
- ❖ The project revealed that the contact angle measurement is far more appropriate to measure the hydrophobicity of paper compared to the conventionally used Cobb₆₀ test.
- ❖ The Cobb₆₀ value could be maintained as 28-30 from present practice of 20-22 without any adverse effect on print or any other functional quality of the paper.

Scientific Development

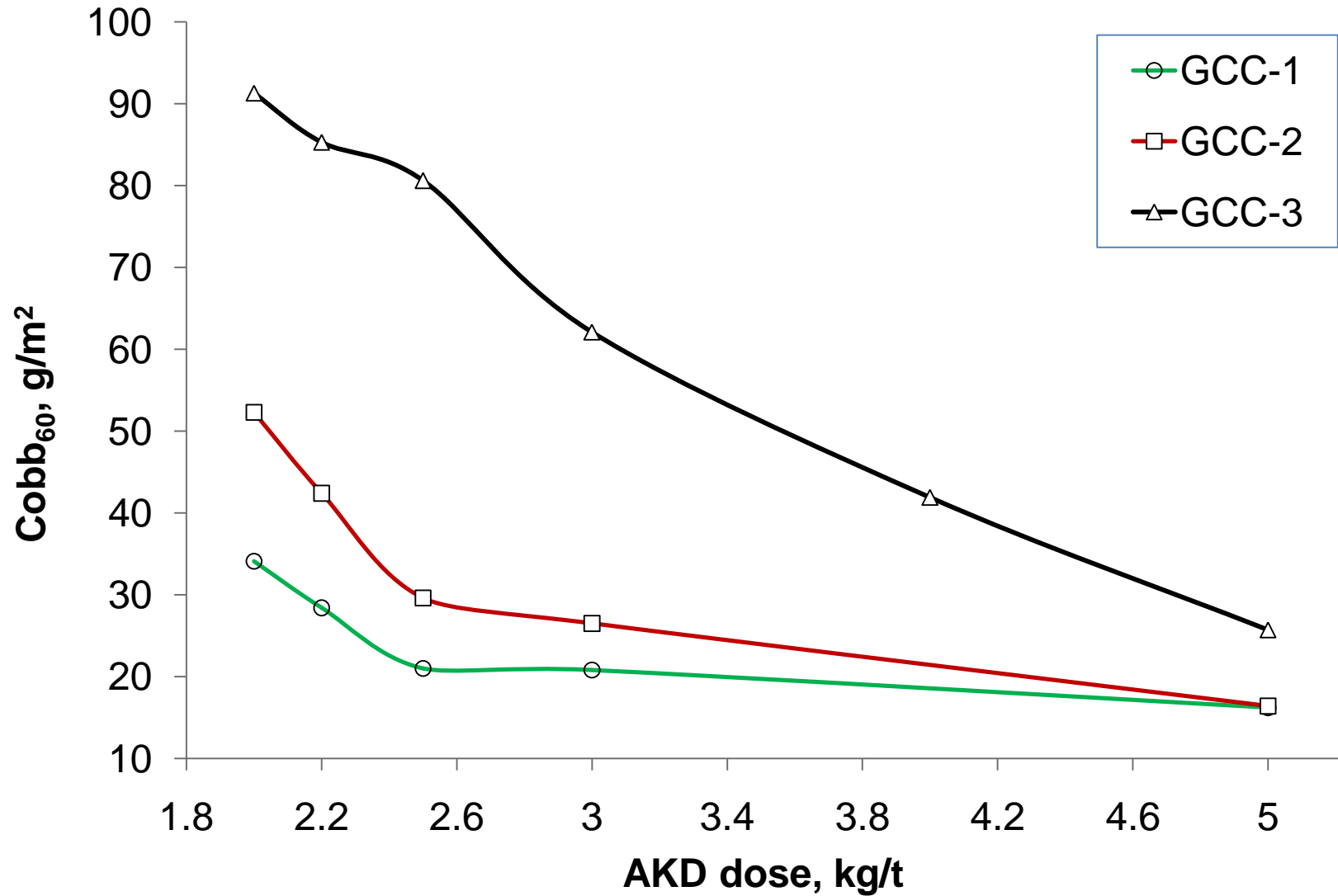
Publication

- ❖ Sharma, A., Kakkar, S., Chauhan, V. S., Bhardwaj, N. K. & Varadhan, R. (2013). Role of AKD and ASA emulsions in improving hydrophobicity of recycled fiber based paper. *Ippta J.*, 25(3), 91–96.
- ❖ Sharma, A., Kakkar, S., Chauhan, V. S., Chakrabarti, S. K. & Varadhan, R. (2012). Efficacy of ASA sizing with agro-residue and recycled pulps using different fillers. *Ippta J.*, 24(3), 93–98.
- ❖ Kumar, S., Chauhan, V. S. & Chakrabarti, S. K. (2012). Separation and analysis techniques for bound and unbound alkyl ketene dimer (AKD) in paper: A review. *Arabian Journal of Chemistry*, doi: <http://dx.doi.org/10.1016/j.arabjc.2012.04.19>.

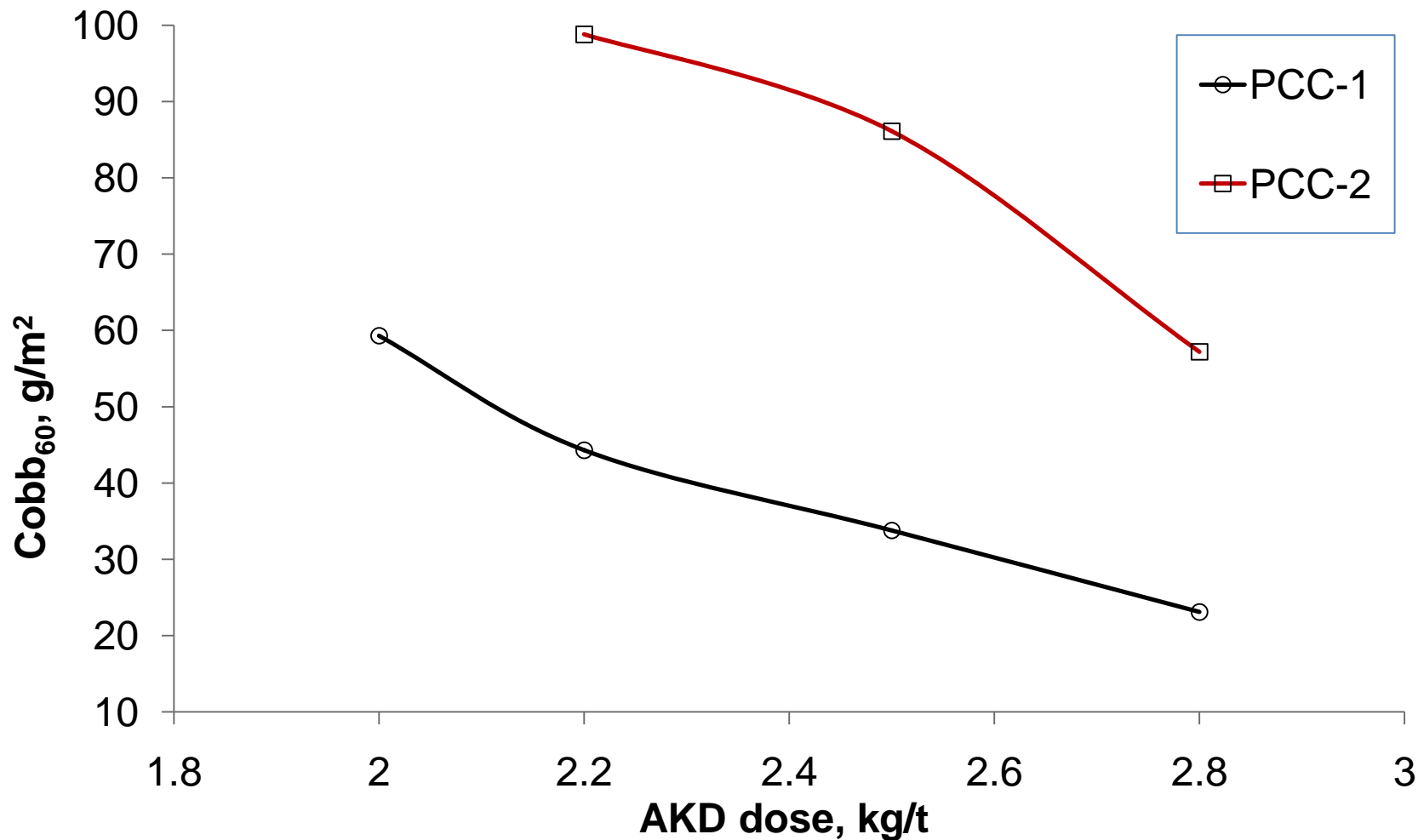
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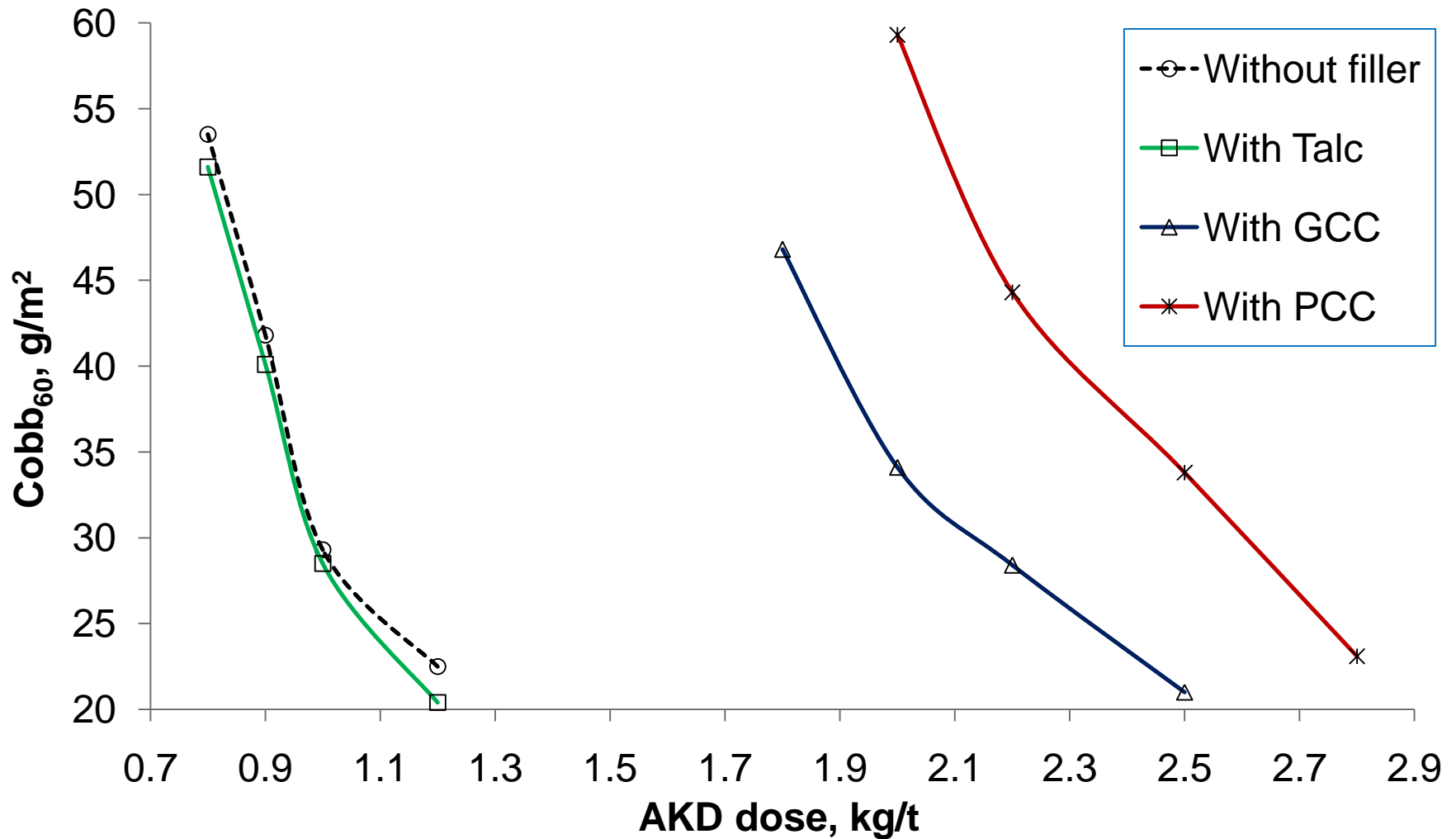
Effect of GCC fillers (from diff sources) on Cobb₆₀ value of paper using AKD as sizing agent



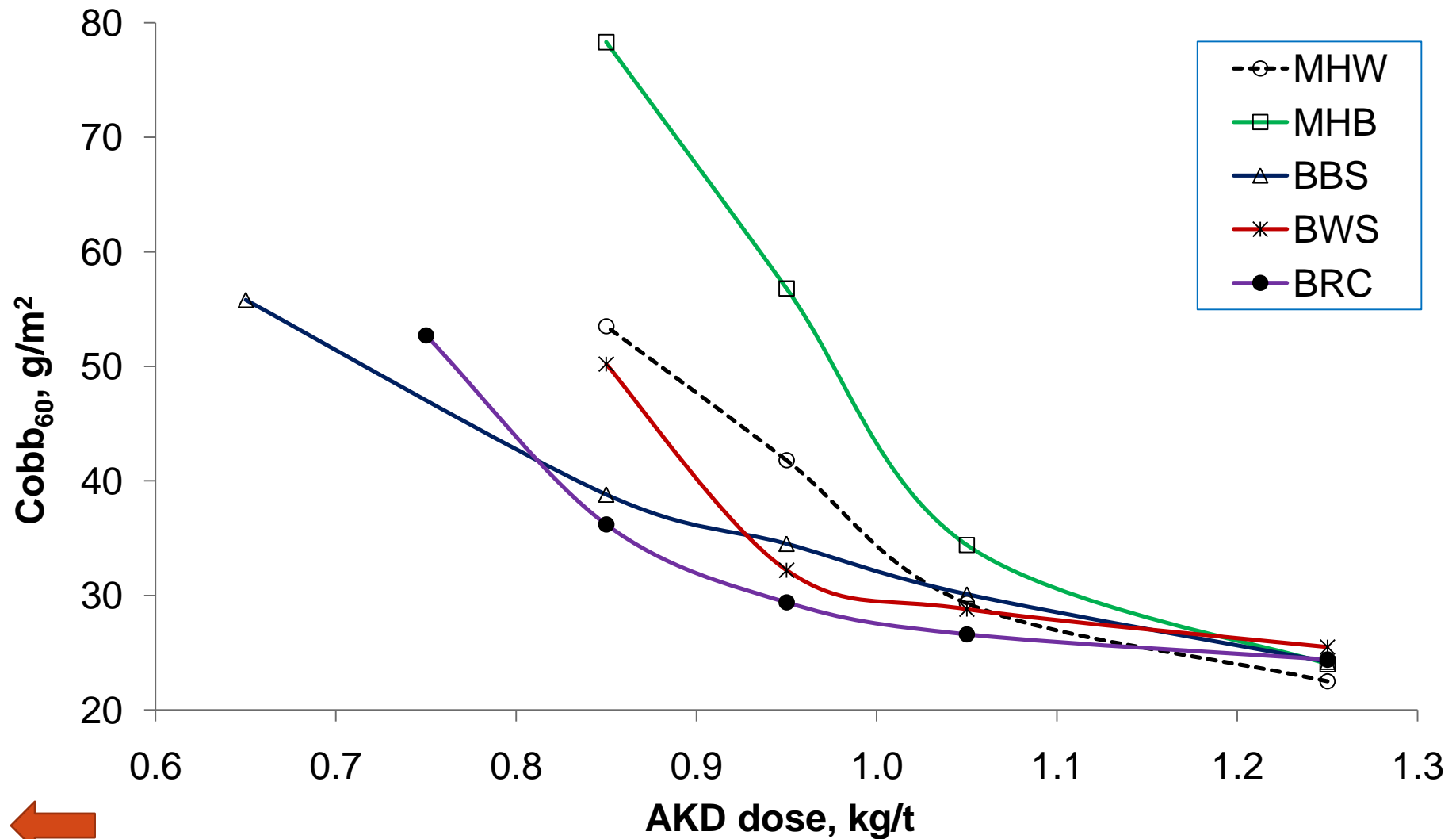
Effect of PCC fillers (from diff sources) on Cobb_{60} value of paper using AKD as sizing agent



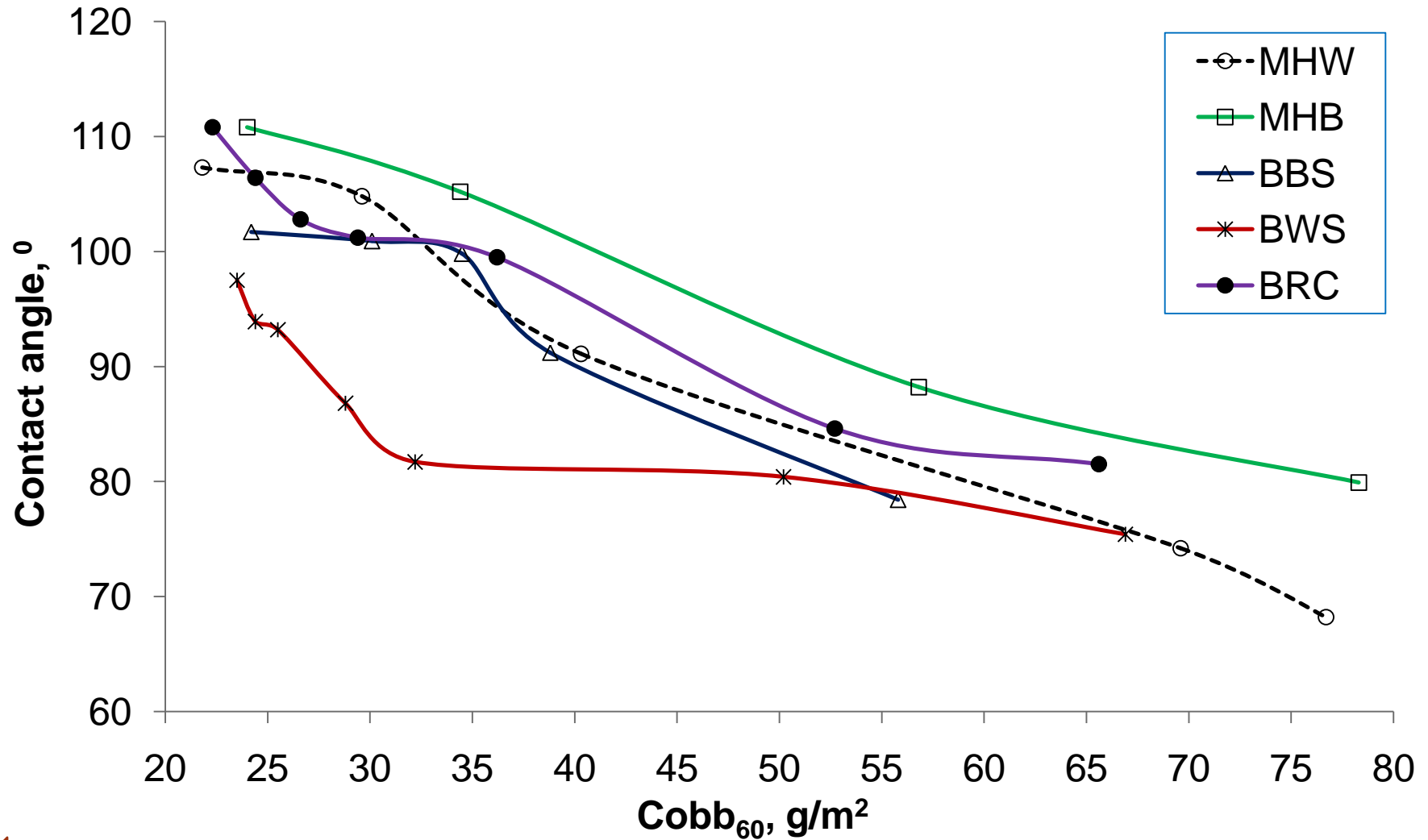
Effect of fillers on Cobb₆₀ value using MHW pulp and AKD sizing agent



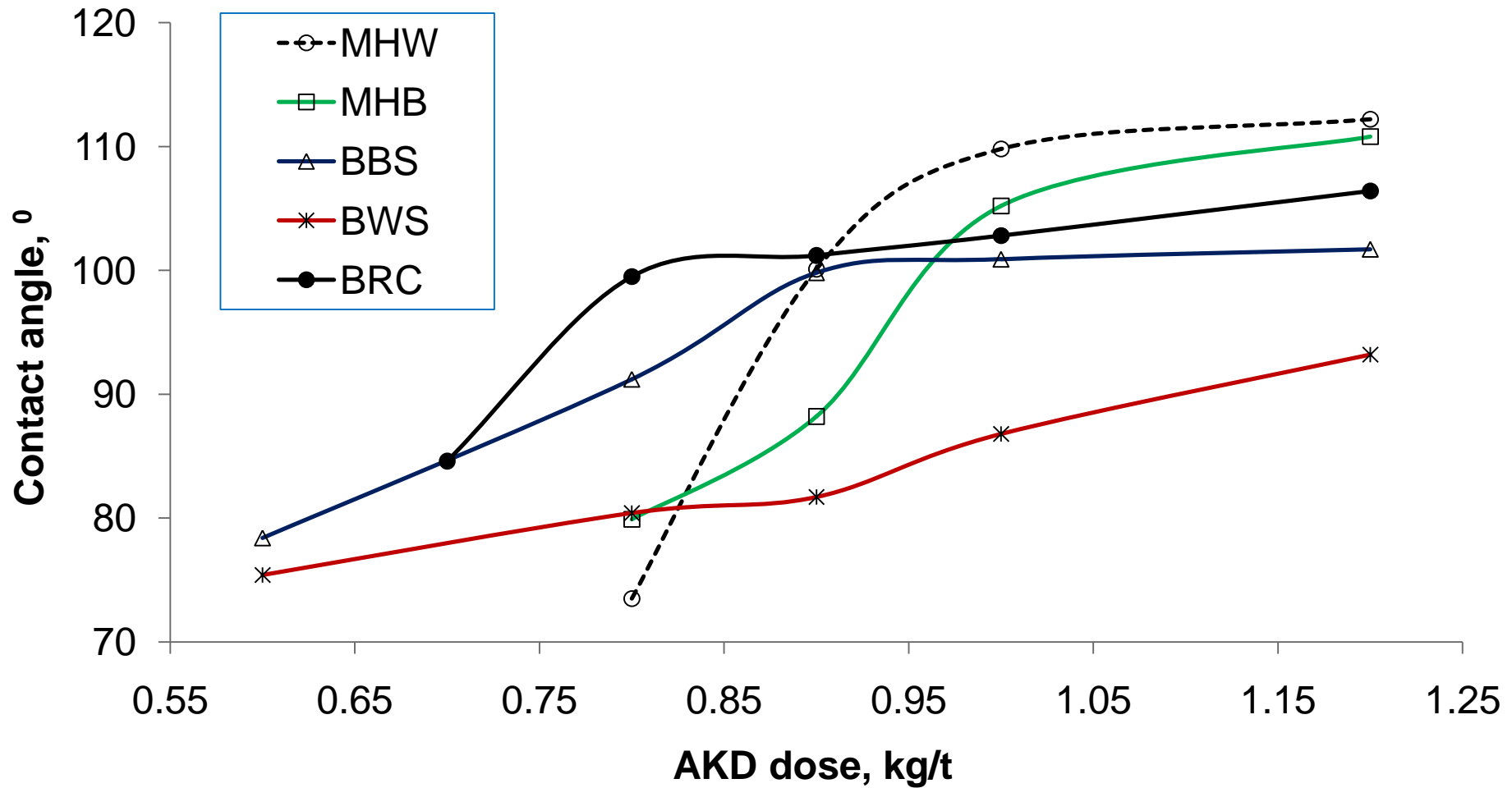
Comparison of $Cobb_{60}$ values of different pulp furnishes in AKD sizing (without filler)



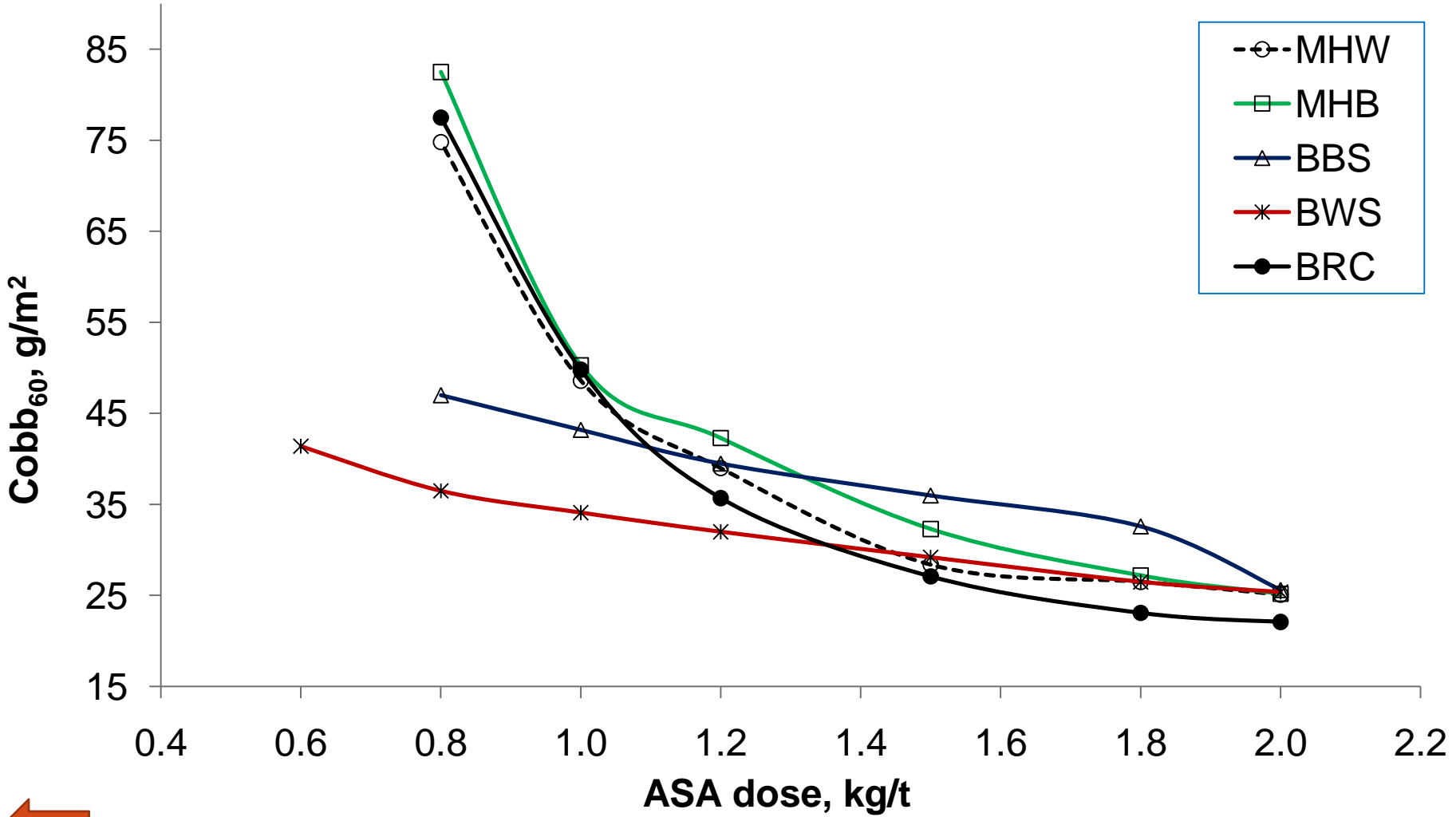
Cobb₆₀ vs. contact angle relationship for different pulp furnishes in AKD sizing (without Filler)



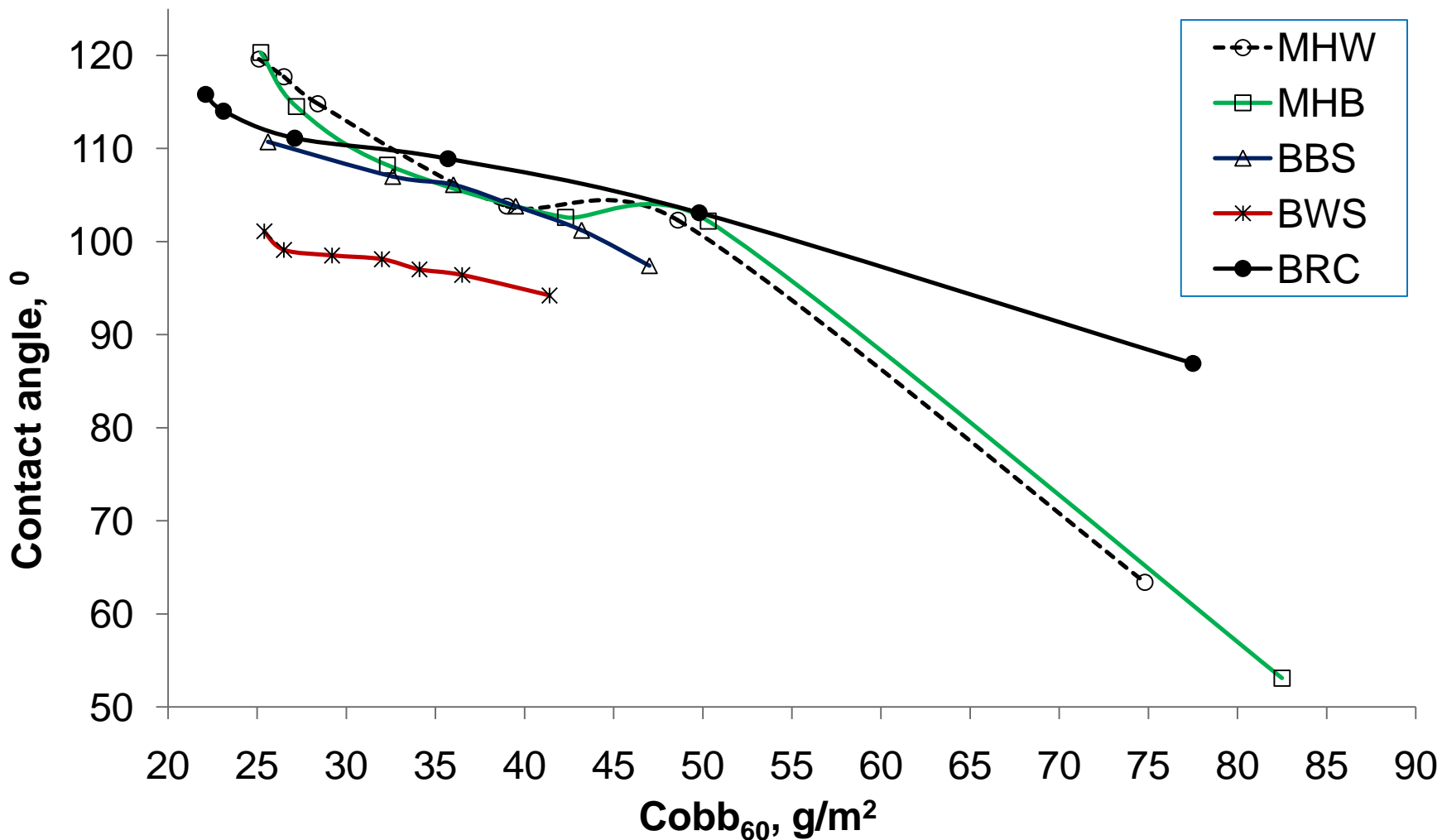
Comparison of contact angle of different pulp furnishes in AKD sizing (without filler)



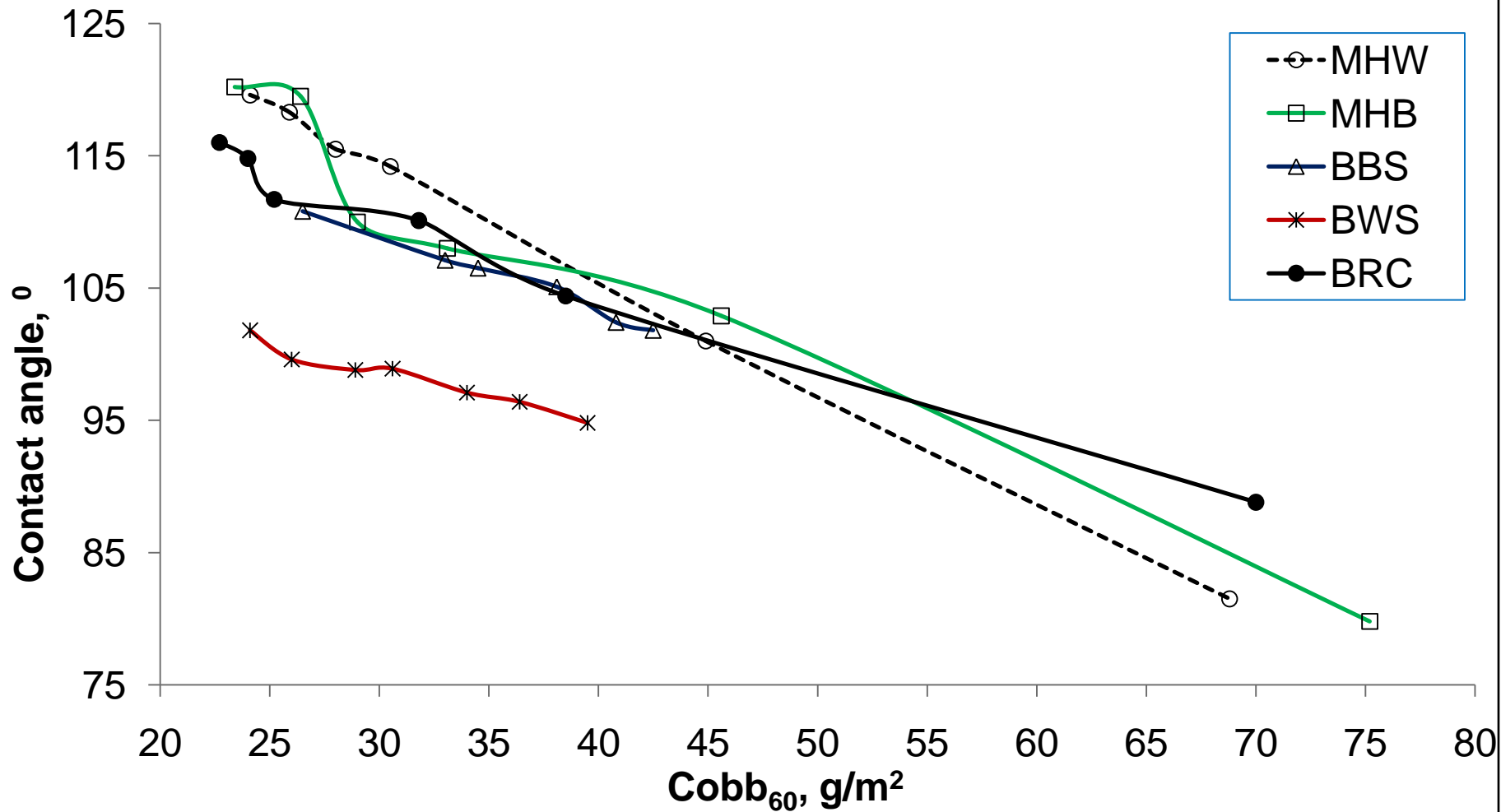
Comparison of Cobb₆₀ value of different pulp furnishes in ASA sizing (without filler)



Cobb₆₀ vs. contact angle relationship for different pulp furnishes in ASA sizing (without Filler)



Cobb₆₀ vs. contact angle relationship for different pulp furnishes in ASA sizing (with talc Filler)



Cobb₆₀ vs. contact angle relationship for different pulp furnishes in ASA sizing (with GCC Filler)

