Surface Charge and Hydrophobicity for Respirable Dust Particles

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INTRODUCTION

Zeta potential and contact angle measurements provide an understanding of the surface charge and hydrophobicity of mineral particles, with applications in respirable dust research and in mineral processing technologies like froth flotation and dewatering. Measured in millivolts (mV), zeta potential measures the attraction and repulsion between mineral particles and the respective liquid they are in. When zeta potential is 0, also known as the isoelectric point, the repulsions are weak, and particles tend to aggregate and settle. As zeta potential increases in absolute value, there are greater repulsions.

Contact angle measurements can be used to find a mineral's hydrophobicity, or how attracted it is to water. Measured in degrees (°), a mineral with a large contact angle will be more hydrophobic, which means it is repelled by water.

OBJECTIVES

- ❑ To gather information on zeta potential and contact angle for the minerals present in coal as a reference for current and future research
- ❑ To understand why zeta potential and contact angle are important characteristics of dust particles

BACKGROUND

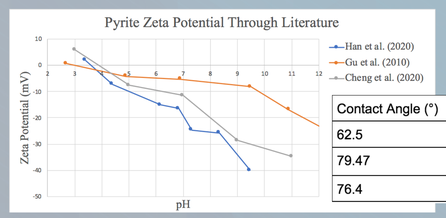
There are real life applications for zeta potential and contact angle. Many natural resources require extraction or separation of certain minerals. The zeta potential provides this information for froth flotation and dewatering. Many materials--oil, coal, and copper, for example-- are studied using zeta potential. Surface charge can also affect the attraction of respirable dust particles to lung tissue.

Contact angle measurements can be used for applications like reservoirs, where the wettability impacts the effectiveness. In terms of production, contact angles are needed for glass, printing, and lubrication, to name a few.

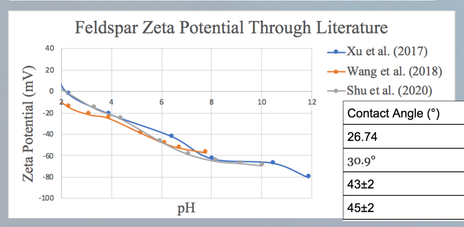
MINERALS RESEARCHED

-Kaolinite -Illite -Quartz -Montmorillonite -Chlorite -Dolomite -Calcite -Feldspar -Pyrite -Rutile -Coal

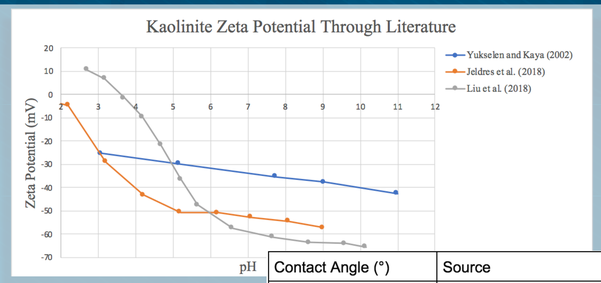
SELECTED RESULTS



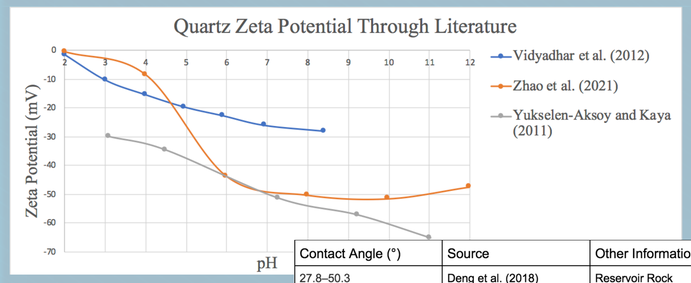
Contact Angle (°)	Source
62.5	Jin et al. (2015)
79.47	Koval and Matysek (2014)
76.4	Cheng et al. (2020)



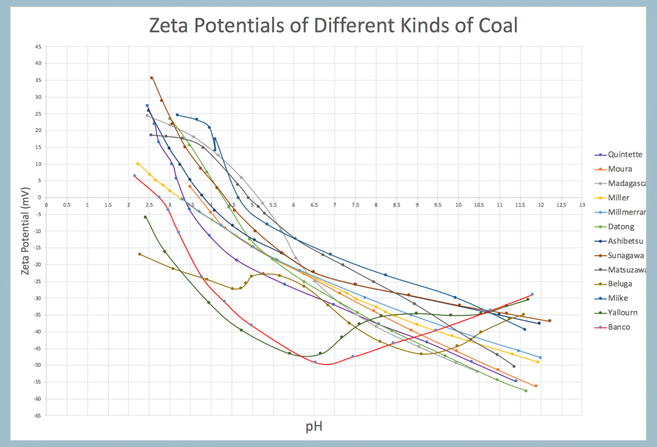
Contact Angle (°)	Source	Other Information
26.74	Xie et al. (2021)	
30.9°	Rao et al. (2021)	K-Feldspar
43±2	Karagüzel et al. (2005)	Na-Feldspar
45±2	Karagüzel et al. (2005)	K-Feldspar



Contact Angle (°)	Source	Other Information
Around 20	Solc et al. (2011)	
19.56	Xi et al. (2020)	
16.9 ∓ 0.7	Shang et al. (2010)	33% Relative Humidity



Contact Angle (°)	Source	Other Information
27.8–50.3	Deng et al. (2018)	Reservoir Rock
35	Szyszka (2012)	
43 ∓ 2	Kowalczyk et al. (1996)	
26.8	Janczuk and Zdziennicka (1994)	
26.15	Xie et al. (2021)	



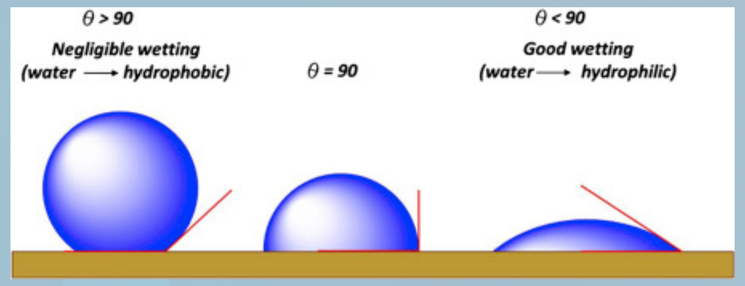
Coal Type	Contact Angle (°)
Taiheiyo upper seam lump	87.3
Taiheiyo 62 slack	90.0
Ashibetsu No. 8 seam lump	87.4
Ashibetsu 70 slack	83.1
Akabira No. 9 seam lump	74.9
Horonai lump	85.7
Miike 66 slack	86.6
Takashima main seam lump	75.6
Indonesia Kalimantan brown coal lump	113.6
Australia Yallourn brown coal lump	89.1
Alaska Beluga brown coal lump	92.7
Indonesia Bangko brown coal lump	97.9

ZETA POTENTIAL METHODS

To begin measuring zeta potential, the fine particles of mineral are placed in solution and dispersed, often by stirring. After the new solution has sat for an adequate amount of time, zeta potential is determined. A tool, usually a type of zeta potential analyzer, is then utilized. Zeta potential is typically recorded as a function of pH, so multiple measurements will be done, making the original solution more basic (with substances like NaOH) or more acidic (with substances like HCl). Other methods include electrophoretic light scattering.

CONTACT ANGLE METHODS

For contact angle, methods include the sessile drop method, captive bubble method, and the thin-layer wicking method. In the sessile drop method, a drop of water is dropped on the mineral, and then a camera and software are utilized. In the captive bubble method, a plate of the mineral is placed in water, and an air bubble is then dropped where the water and mineral meet. The TLW method involves using slides of the minerals and submerging them in water.



CONCLUSIONS

Organizing this data assists future research, providing accessible information to reference and to understand why mineral particles might behave the way they do.

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REFERENCES- available upon request

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