Crack formation during filtration and new method improve dewatering in case of Vietnam fine coal

Crack formation during filtration and new method to effectivelly dewatering in case of Vietnam fine coal

1. Cuaong coal washing technology and motivation
2. Method, equipments, and relevance parameters
3. Investigation some parameters effect on crack formation
4. Next steps...

1. Cuaong coal washing technology and motivation

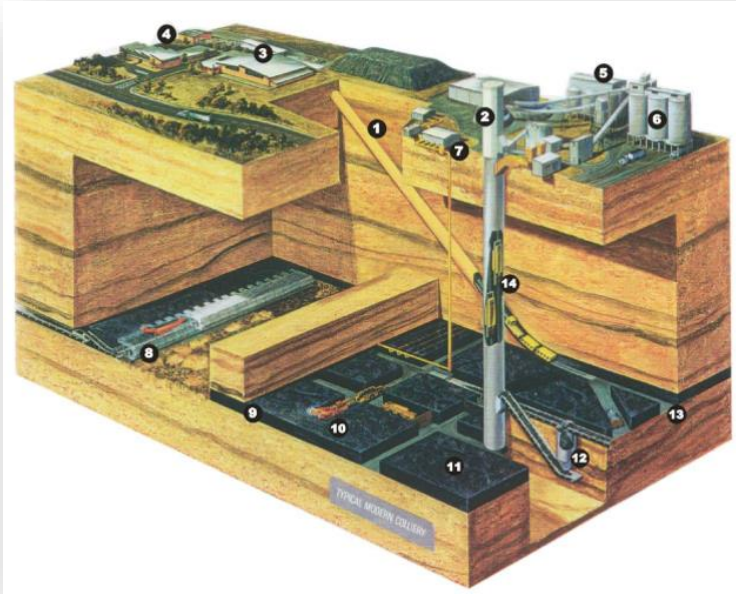
Source: Google map

1. Cuaong coal washing technology and motivation

Tourism, coal industry and export, import trade activities

Source: Internet

1. Cuaong coal washing technology and motivation

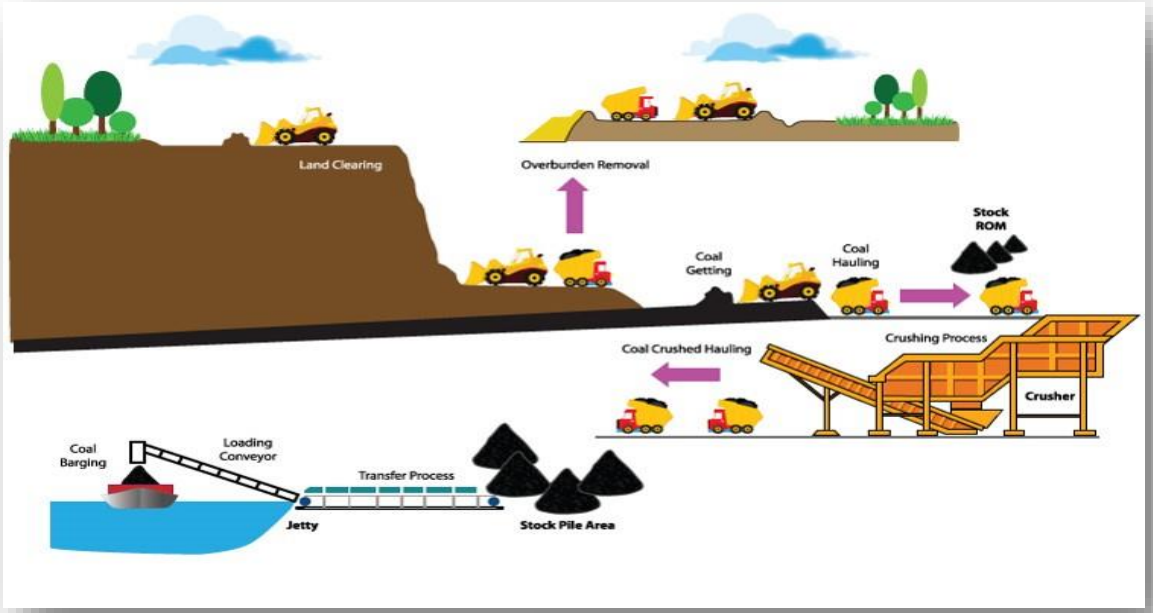


1. Drift (rail)
2. Ventilation fan
3. Pit top
4. Offices
5. CHPP
6. Coal load out bins
7. Mine services
8. Longwall face
9. Coal seam
10. Development section
11. Coal pillar
12. Underground bin
13. Pit bottom
14. Shaft (elevator)

Underground Mining

- 350 m deep

1. Cuaong coal washing technology and motivation



Surface Mining

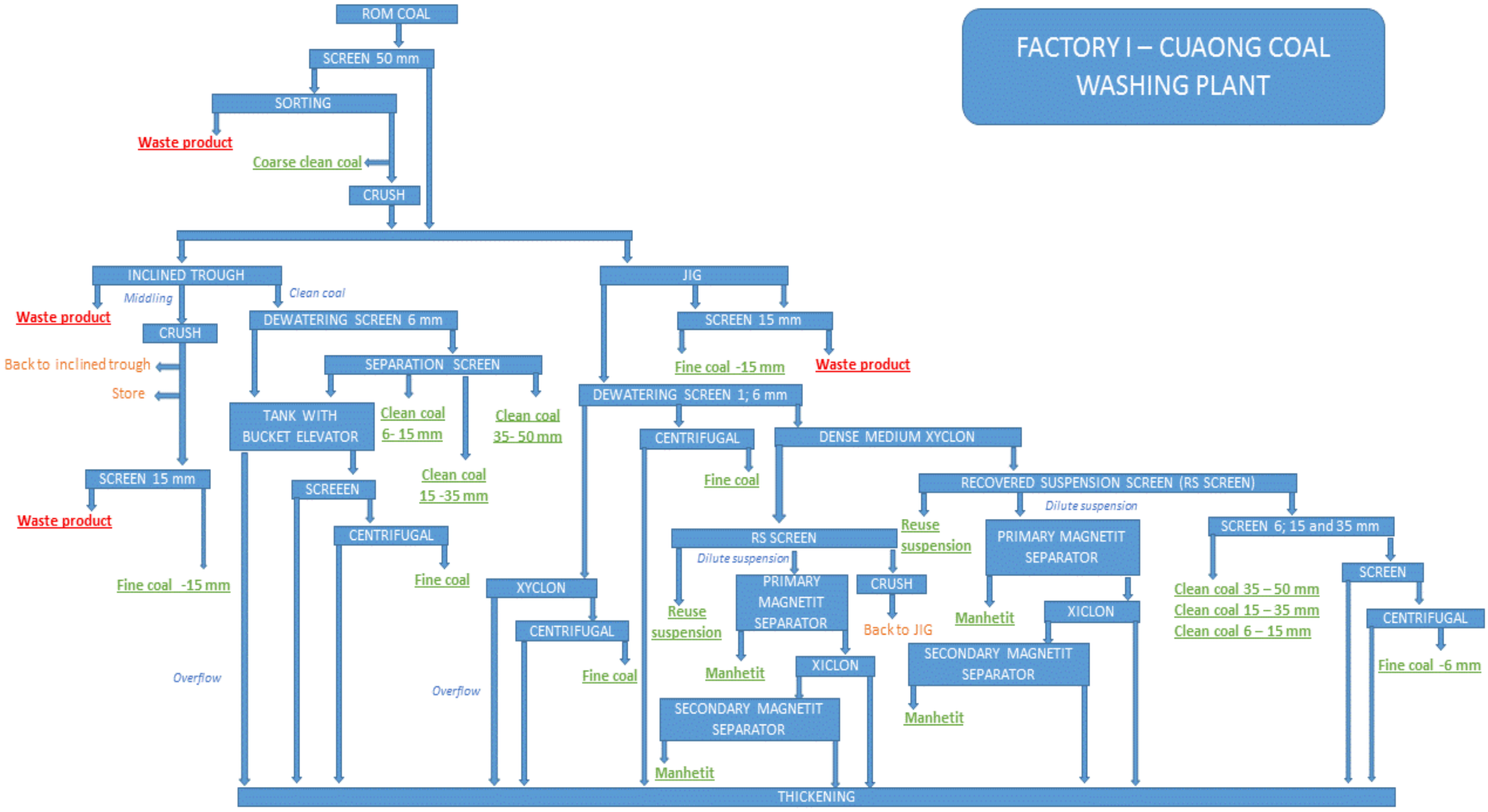
Striping ratio:10.4

1. Cuaong coal washing technology and motivation

Cuaong coal washing plant is established in 1924 in Quang ninh province, Vietnam.
A bigest plant in Vietnam with avearge capacity up to 12 milion ton coal ROM, which are from almost coal mining company

Playing importance role in Vietnam coal industry including logistic, production, processing and product consumption...
Having many modern equipments with advance technologies on the world from Germany, Australia, Japan, Poland and China

1. Cuaong coal washing technology and motivation



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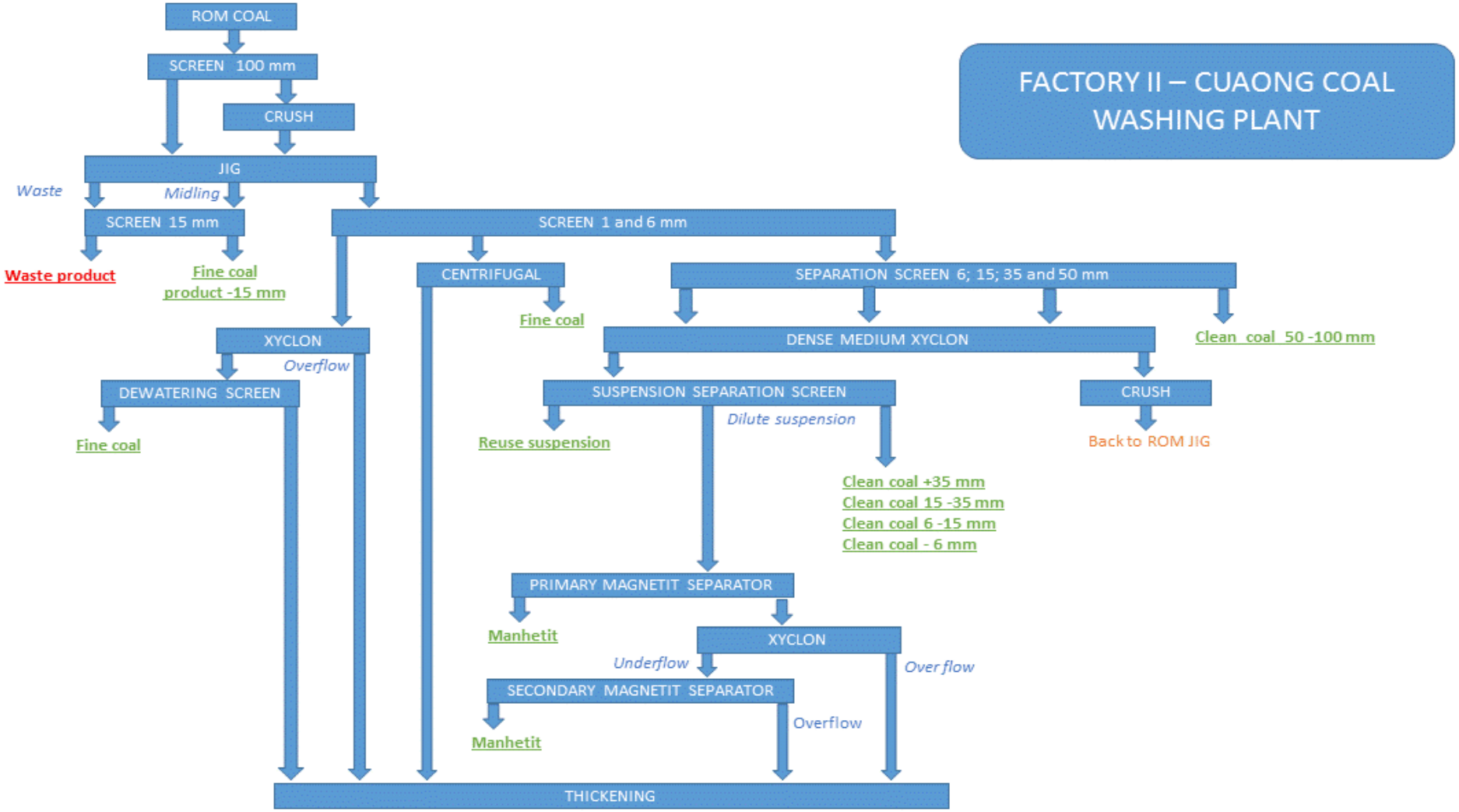

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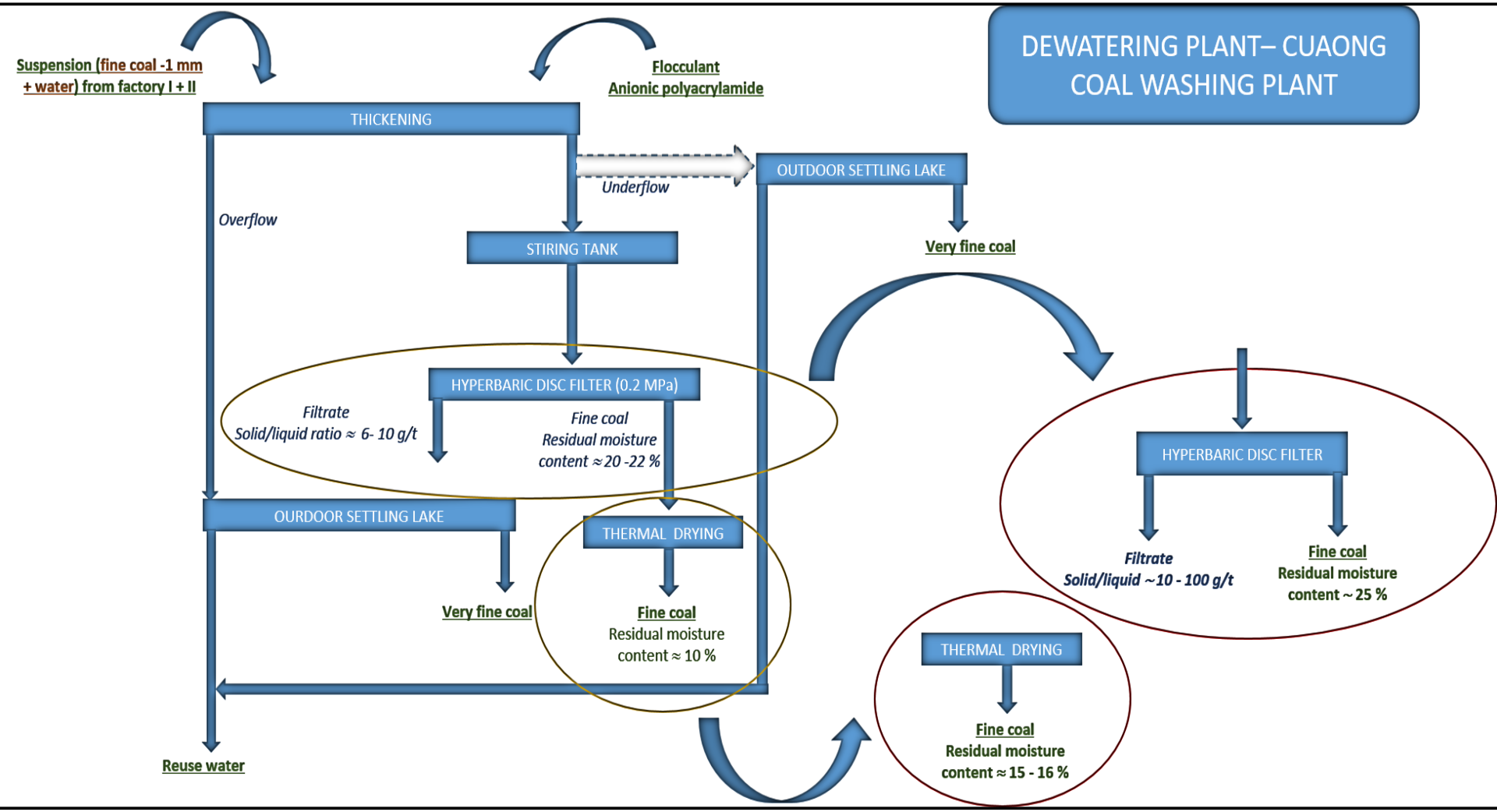


1. Cuaong coal washing technology and motivation

Fine coal (<1 mm) after washing which is dewatered by hyperbaric pressure filter and thermal drying.

The residual moisture content of fine coal after filtration is usually 20-22% (sometime up to 25%) and the amount of remaining water in fine coal after drying is 10% (sometime up 15 -16 %).

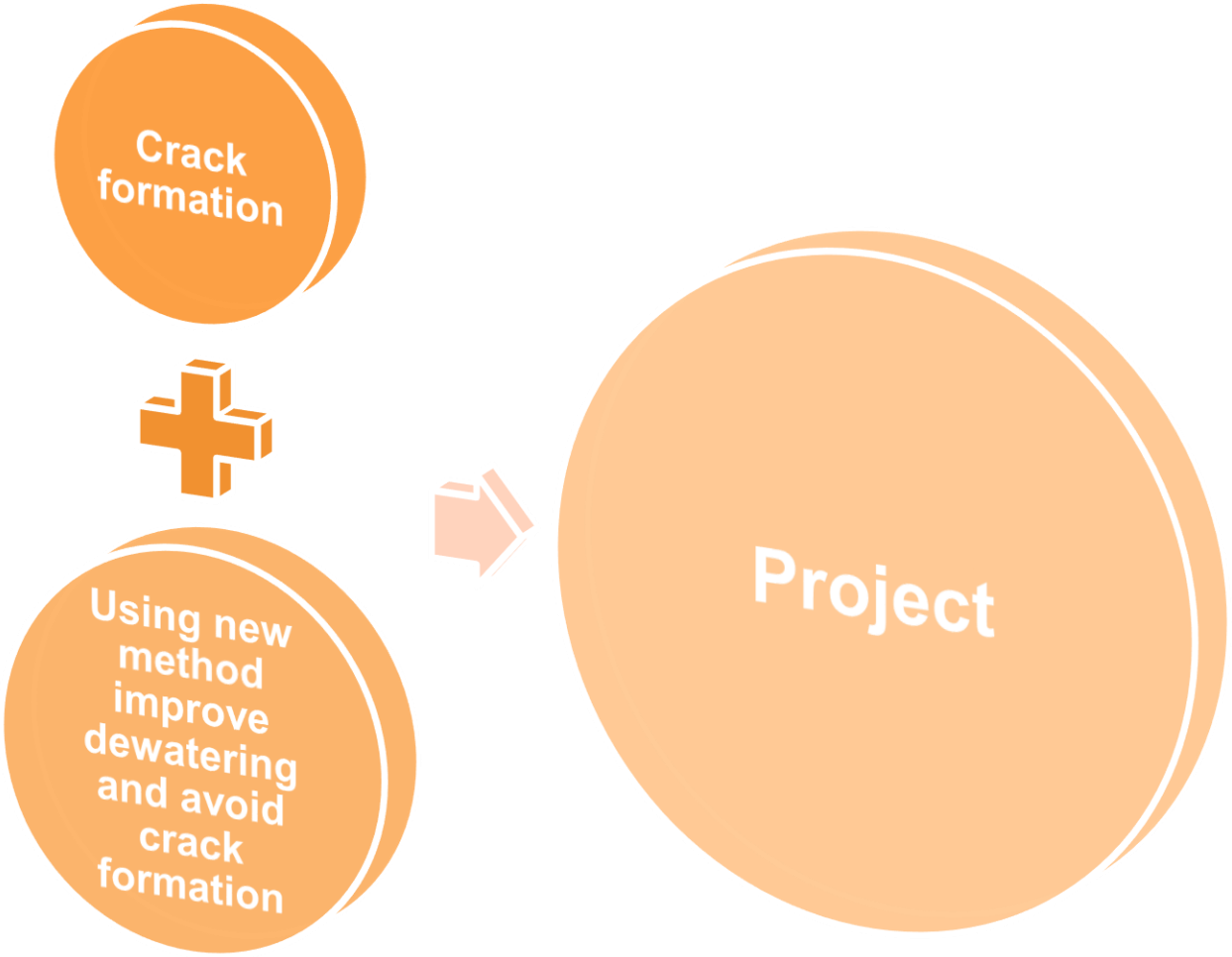
However, on Vietnam standard, the average moisture content is 8% for commercial fine coal

<u>This problem leads to:</u>

+ Water in the filter cake can not be recycled → Increasing of production costs
+ Increasing of the transport costs
+ Reduce the product value
+ Difficult to mixing with other kind of coal
+ Difficult in store → Affect on the environment

1. Cuaong coal washing technology and motivation

PhD project



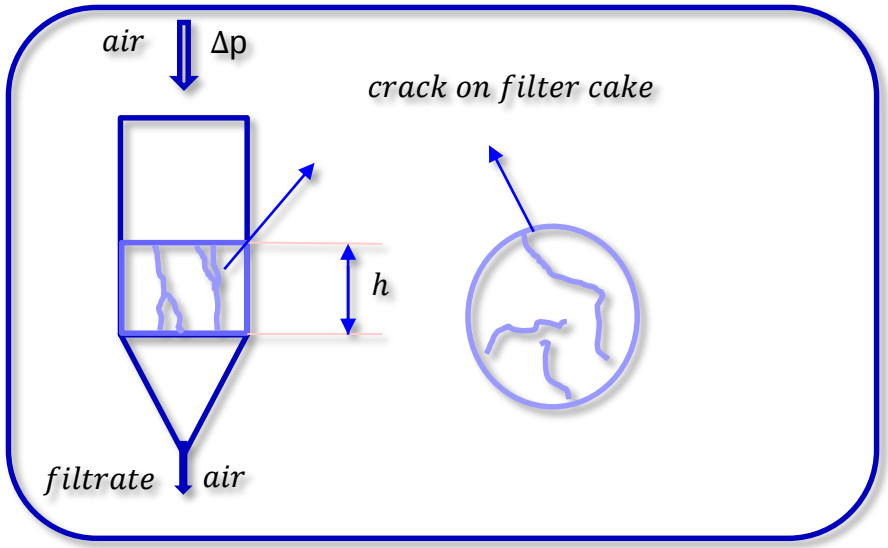
1. Cuaong coal washing technology and motivation

Crack formation

The crack is formed during filtration and washing process and is the undesired phenomenon

This phenomenon lead to:

- Higher gas/water washing consumption/ A decrease in filtration pressure
- Higher residual moisture content, the filtrate is less purity

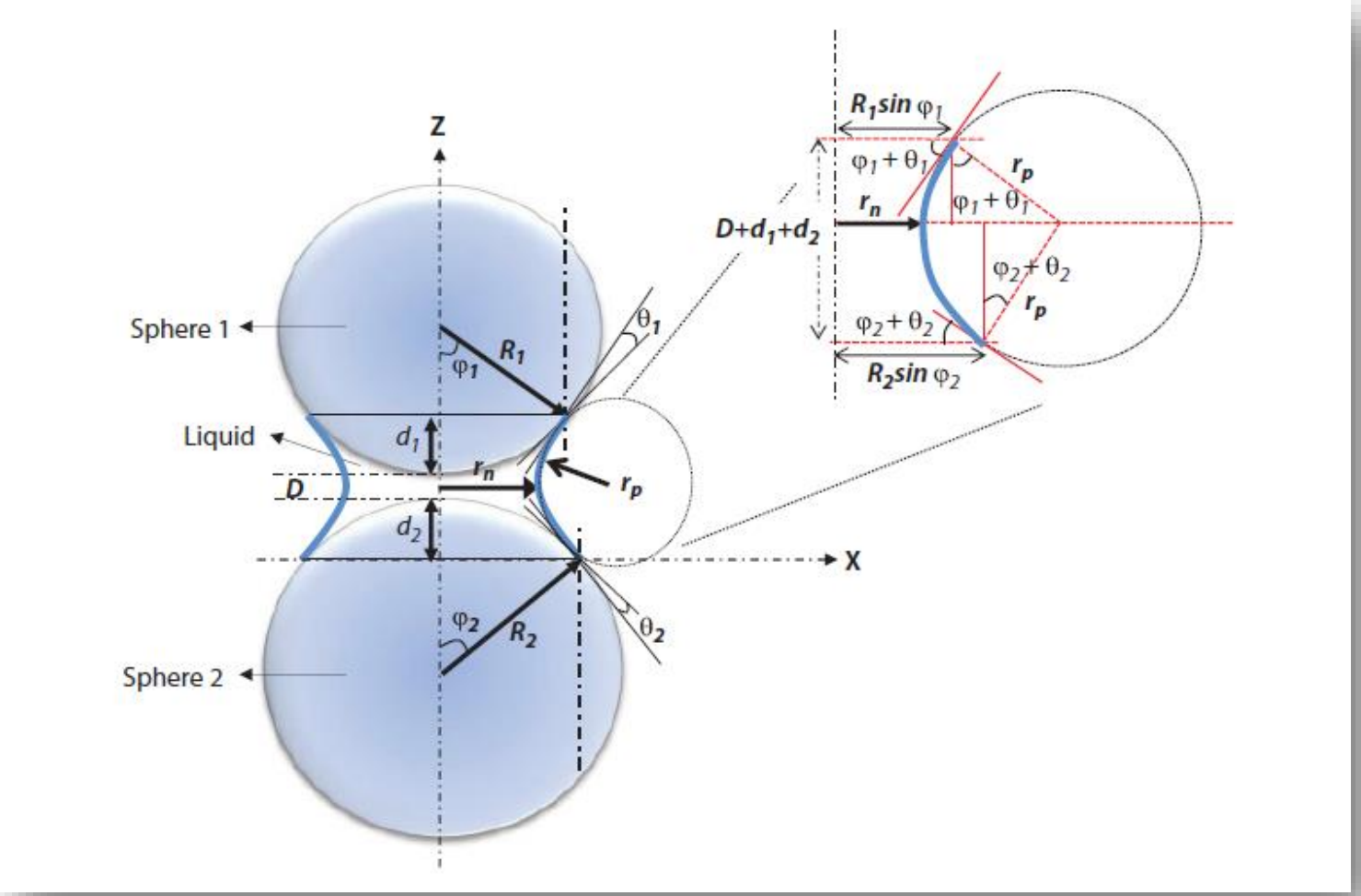


⇒ Objective: Investigate the effect of factors on crack formation of filter cake, quantification of cracks and methods to avoid cracks.

1. Cuaong coal washing technology and motivation

Crack formation because of stresses generated by capillary force

The formation of crack is generally caused by the shrinkage of the filter cake, which is a result of the action of capillary force (Wiedemann and Stahl 1996)



1. Cuaong coal washing technology and motivation

Crack formation because of stresses generated by capillary force

Total capillary force between two spheres linked by liquid bridge:

$$F_{cp} = A_{xy}\gamma_l\left(\frac{1}{r_p}+\frac{1}{r_n}\right) = \pi r_c^2\gamma_l\left(\frac{\cos(\theta_1+\varphi_1)+\cos(\theta_2+\varphi_2)}{D+d_1+d_2}+\frac{1}{r_n}\right)$$

For large spheres (R_1 and R_2 >>> D and R_1 and R_2 >>> d):

$$F_{cp}^{R_1,R_2\gg D,\,R_1,R_2\gg d} = \pi r_c^2\gamma_l\left(\frac{cos(\theta_1)+cos(\theta_2)}{D+d_1+d_2}\right)$$

If both spheres are identical:

$$F_{cp}^{R\gg D,R\gg d} = \frac{2\pi R\gamma_l cos(\theta)}{1+D/2d}$$

Stephen Beaudoin1, P. J., Aaron Harrison1, Jennifer Laster1, and M. S. Kathryn Smith1, and Myles Thomas1 "Fundamental Forces in Particle Adhesion." (Particle adhesion and removal).

2. Equiments and relevance parameters

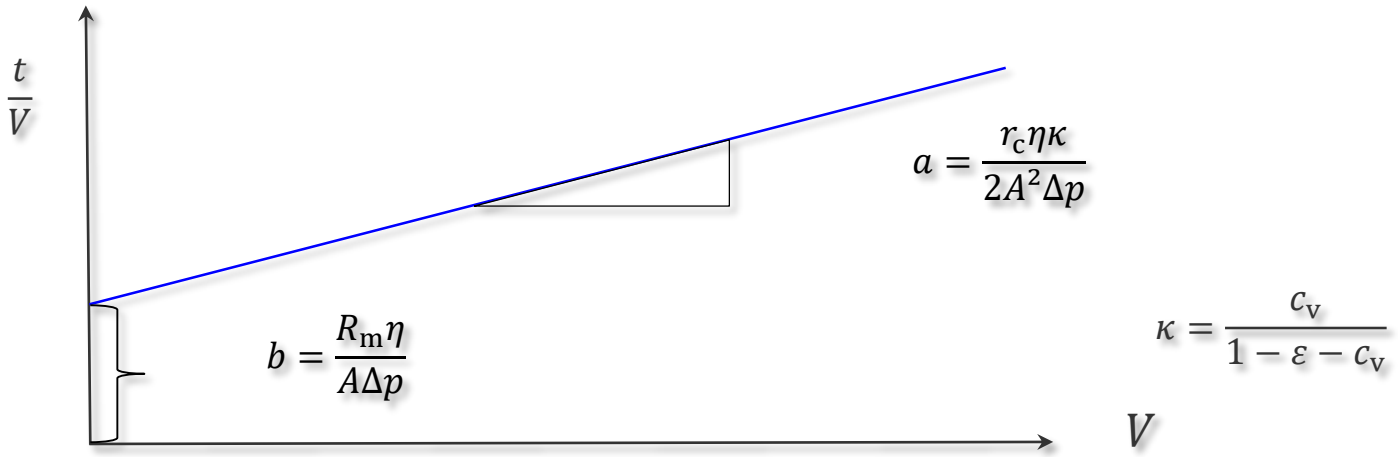
Permeability ratio $\beta = \frac{K_G}{K_L} = r_c * K_G$

$$K_L = \frac{1}{r_c}$$

$$K_G = \frac{2(p * \dot{V})_t * \eta_G * h}{A * (p_1^2 - p_2^2)}$$

$$r_c = \frac{a.2.\Delta p.A^2}{\eta_L.\kappa}$$

[Wyckoff et al]



[Darcy]

2. Equiments and relevance parameters

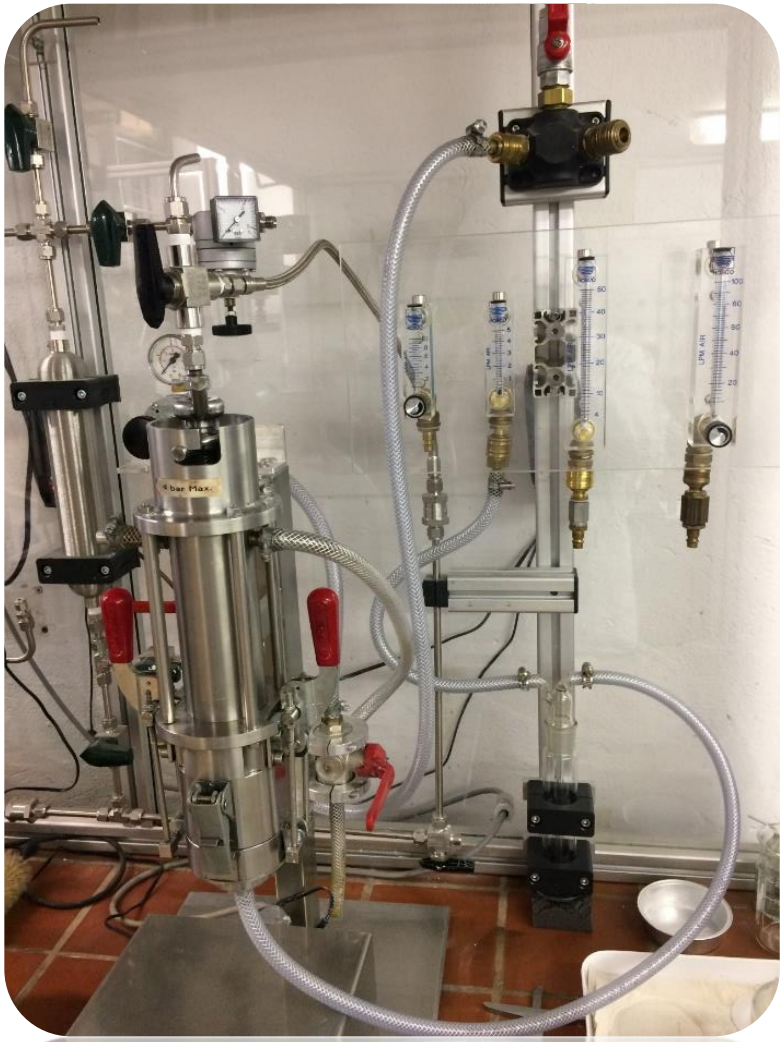
Porosity $\varepsilon = \frac{V_{pore}}{V_{total}} = \frac{h.A - m_{solid}/\rho_{solid}}{h.A}$

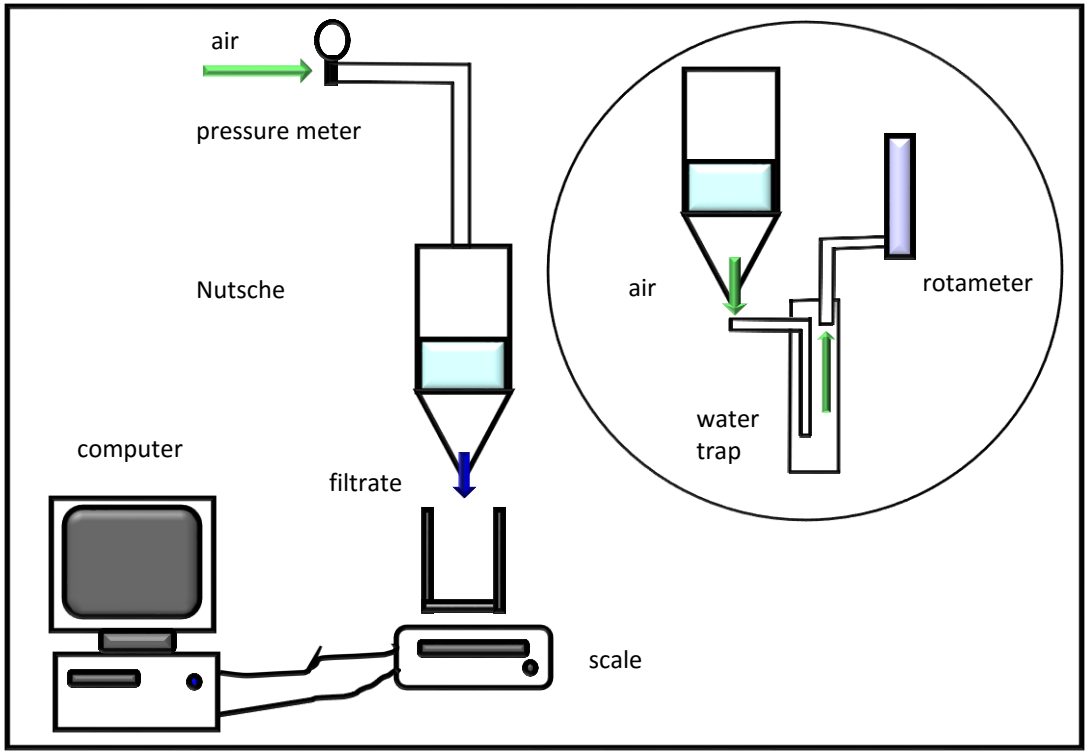
Saturation $S = \frac{V_{remaining\ liquid\ in\ filter\ cake}}{V_{pore}} = \frac{V_{remaining\ liquid\ in\ filter\ cake}}{\varepsilon.h.A}$

Specific resistance cake $r_c = \frac{a.2.\Delta p.A^2}{\eta_L.\kappa}\ (m/kg)$

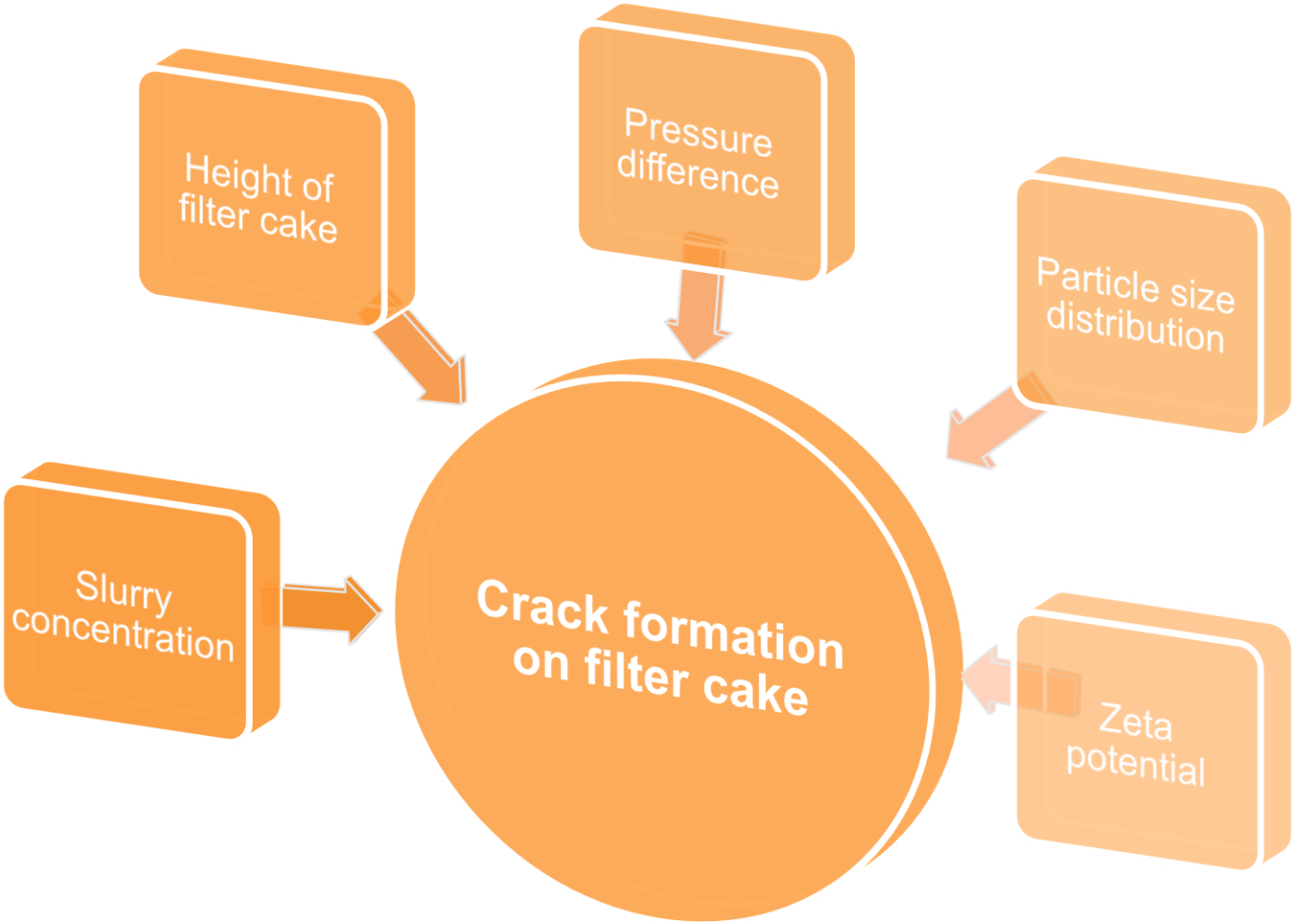
Residual moisture content $M = \frac{m_{liquid}}{m_{wet\ in\ filter\ cake}} * 100\%$

2. Equiments and relevance parameters





3. Investigation some parameters effect on crack formation

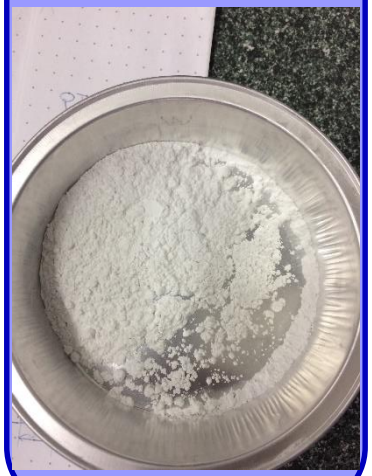


During early stage, limestone is used to replace Vietnam coal because of some purposes:

- ✓ Making accquaitance with lab equipment, tests...
- ✓ Understanding more crack formation mechanism, dewatering mechanism and reduction capability of degree of crack using steam pressure filtration

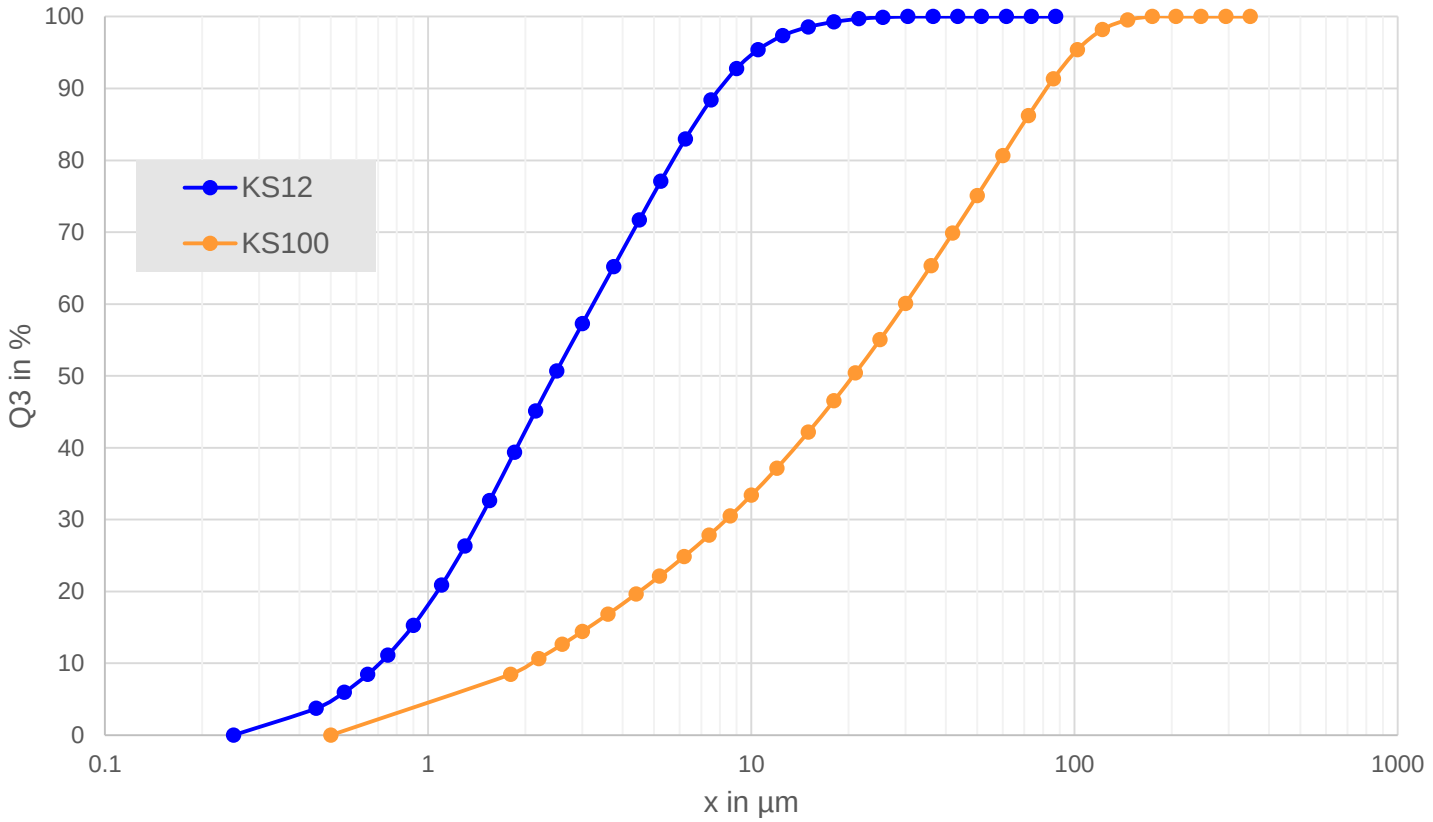
KS12
(x_{50} = 2.46 µm)

KS100
(x_{50} = 20.68 µm)



TEST

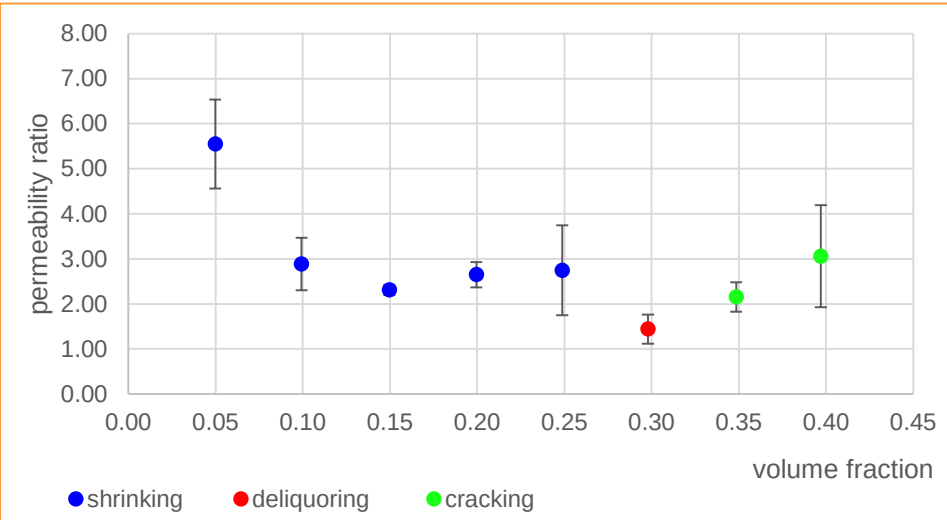
3. Results and discussion with limestone

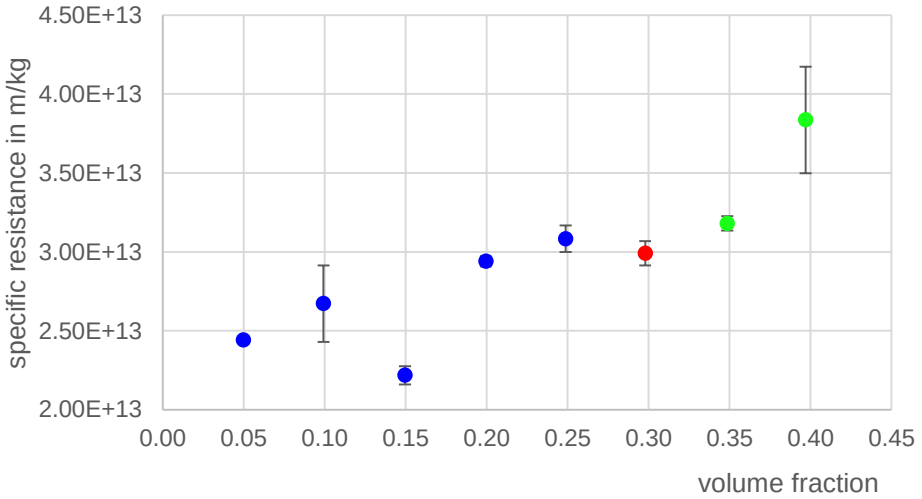


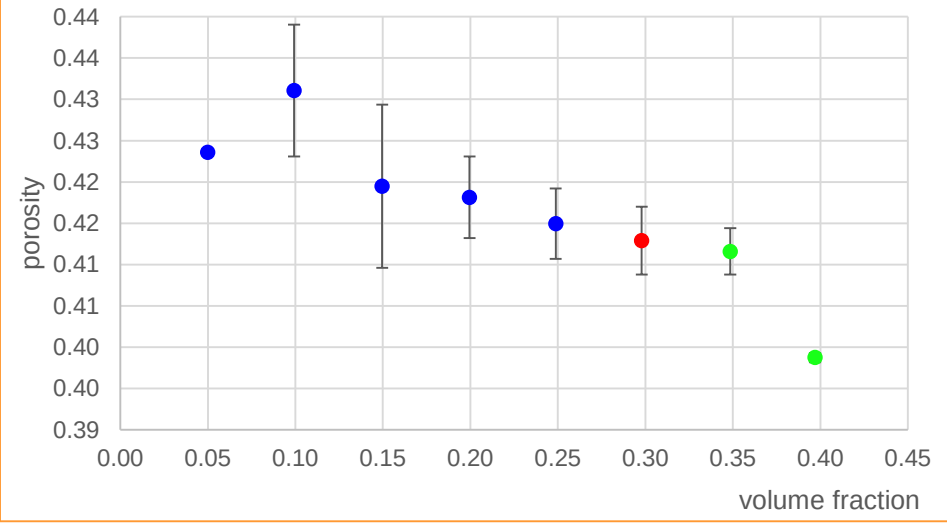
	x_{16}	x_{10}	x_{50}	x_{90}/x_{10}	x_{90}	$(X_{90}-X_{10})/X_{50}$
KS 12	*0.93*	*0.71*	*2.46*	*11.34*	*8.05*	*2.98*
KS100	*3.39*	*2.08*	*20.68*	*39.61*	*82.38*	*3.88*

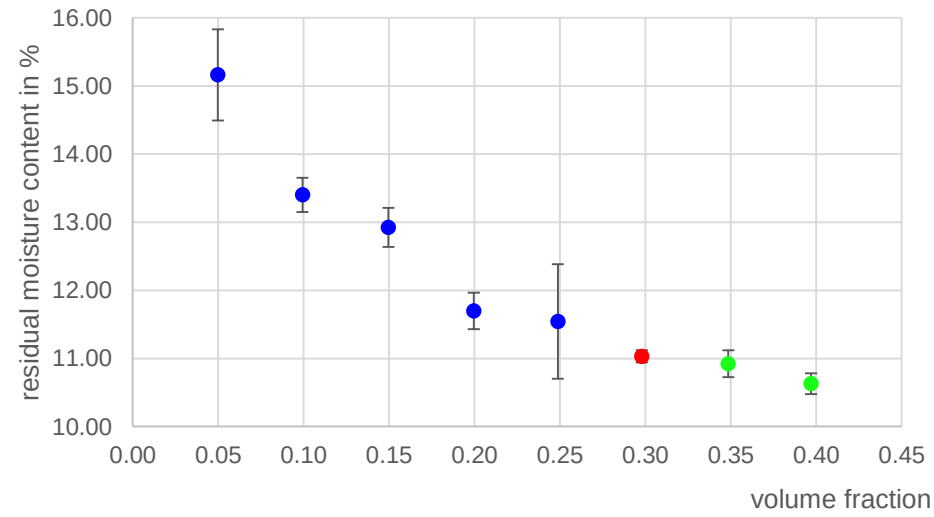
3. Results and discussion with limestone

Effect of volume fraction on crack formation for KS100









Effect of volume fraction on carack formation for KS100

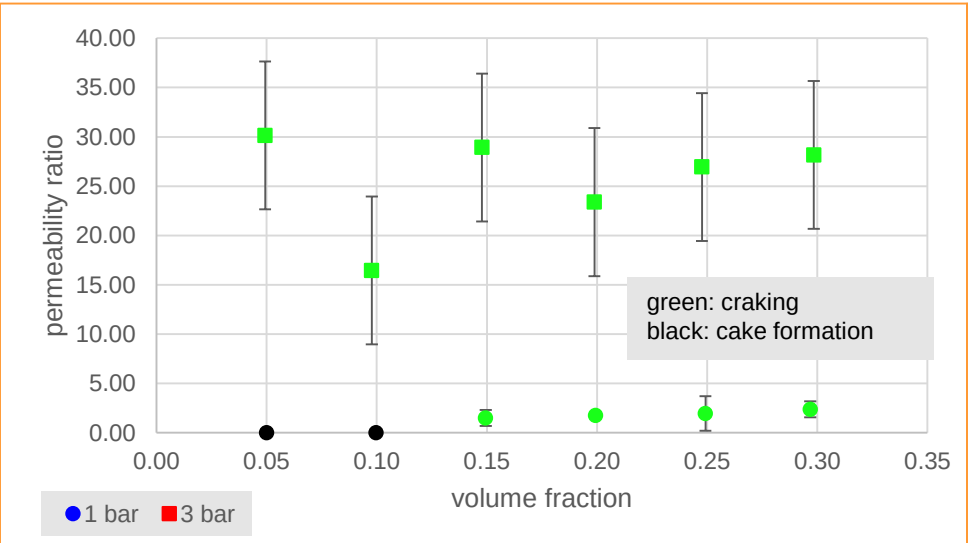
Cv = 0.1

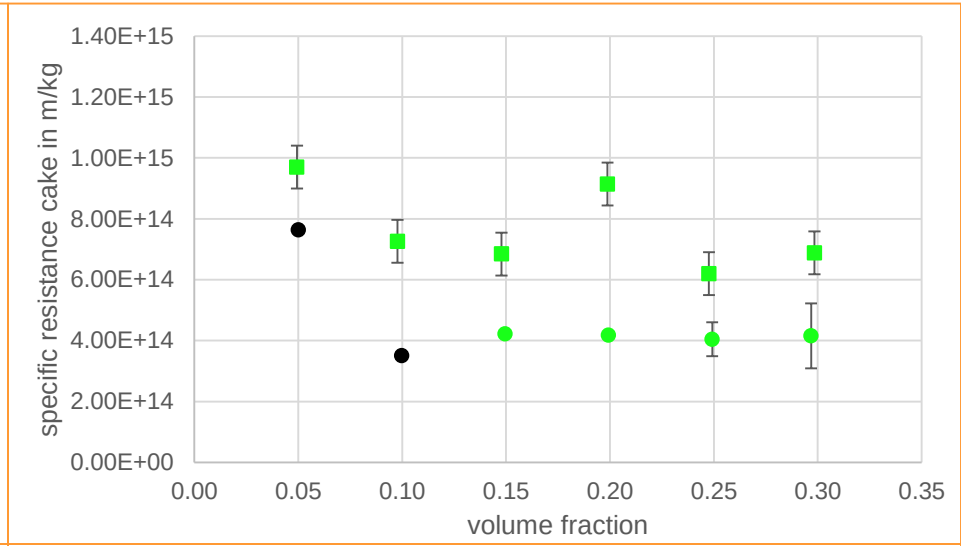
Cv = 0.3

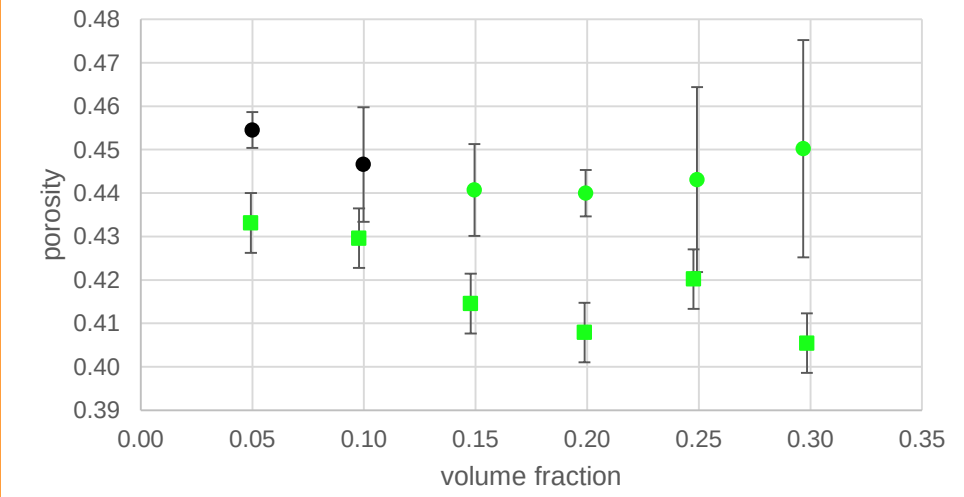
Cv = 0.35

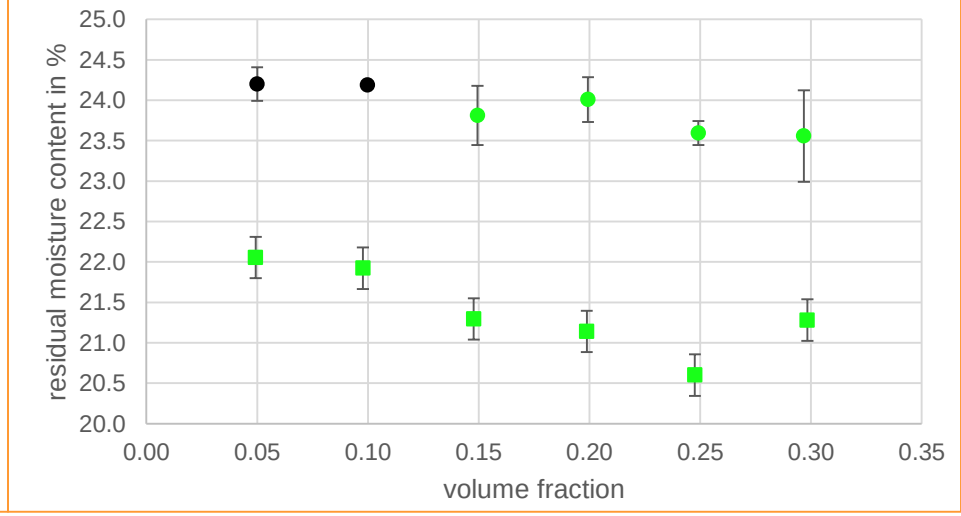
3. Results and discussion with limestone

Effect of volume fraction on crack formation for KS12







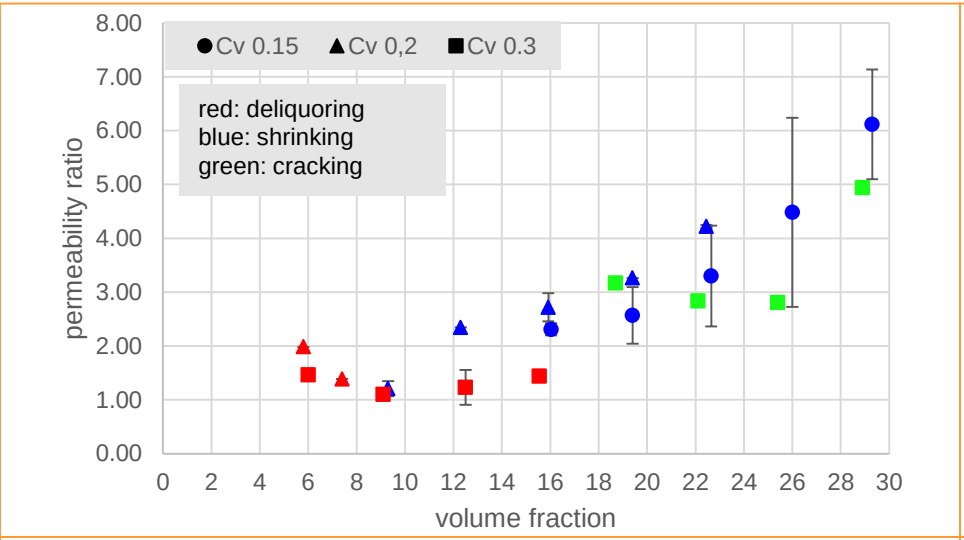


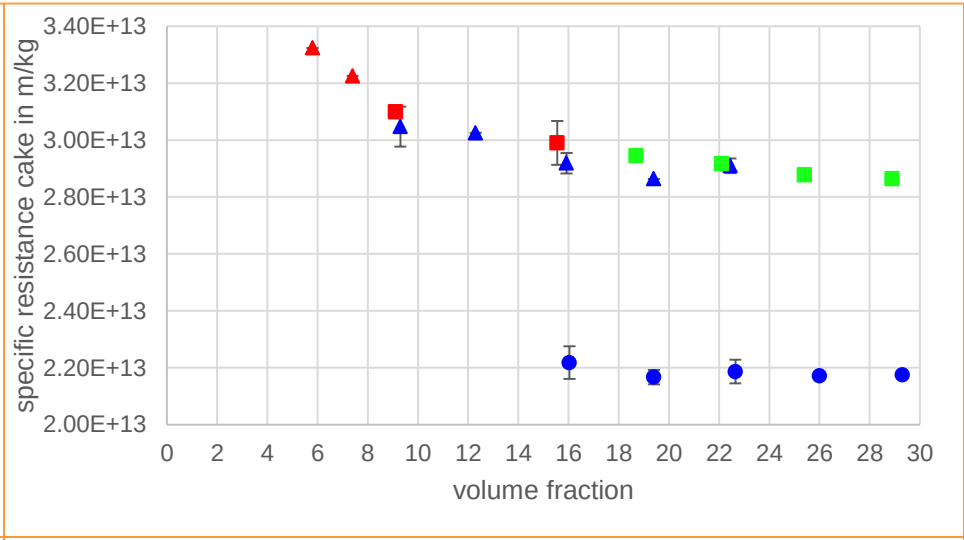
Effect of volume fraction on crack formation for KS12

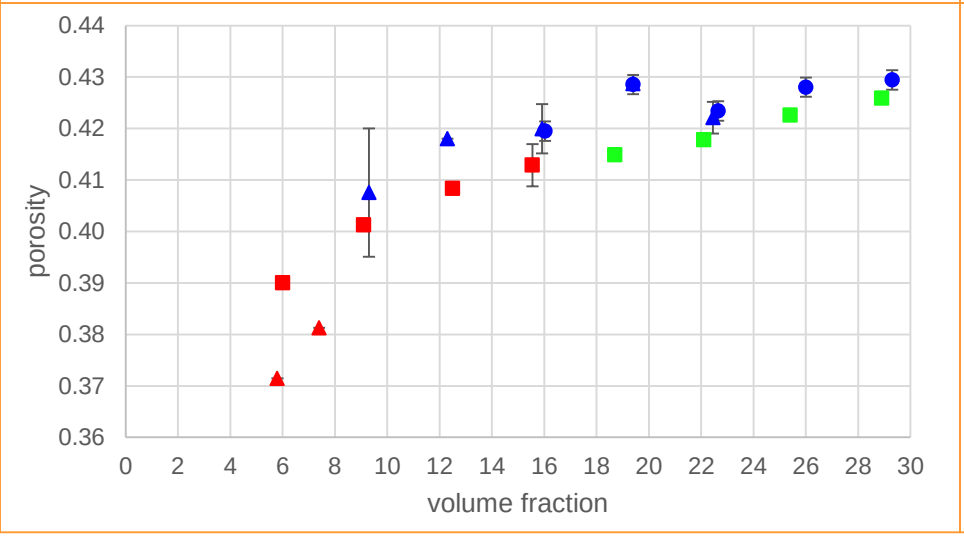
Cv =0.15 ΔP = 3 bar	Cv =0.3 ΔP = 3 bar	Cv =0.15 ΔP = 1 bar	Cv = 0.3 ΔP = 1 bar

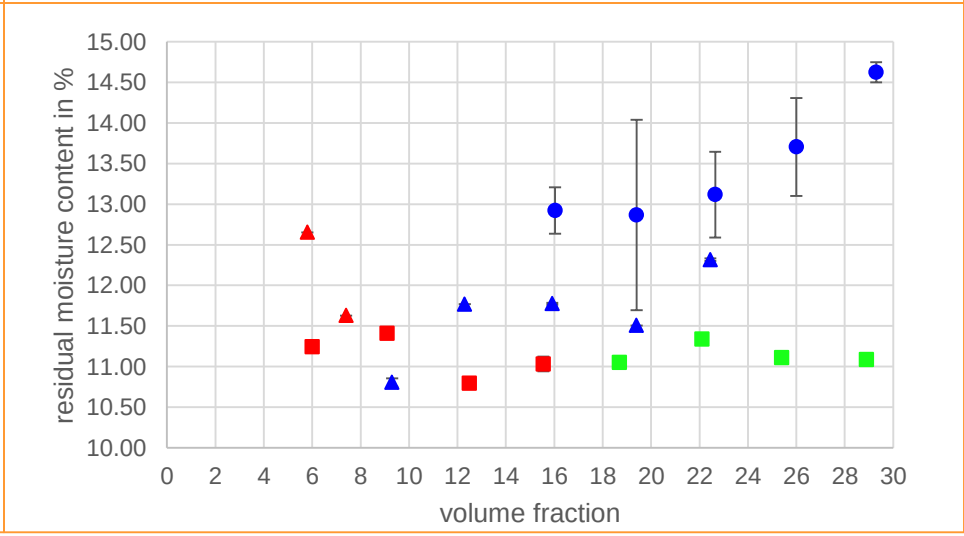
3. Results and discussion with limestone

Effect of height of filter cake on crack formation for KS100









Effect of height of filter cake on crack formation for KS100

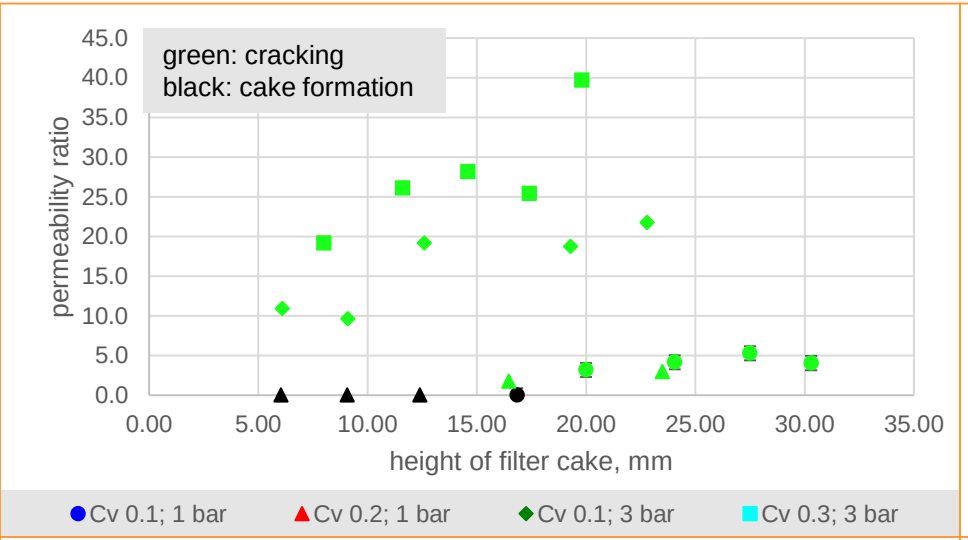
H = 6 mm

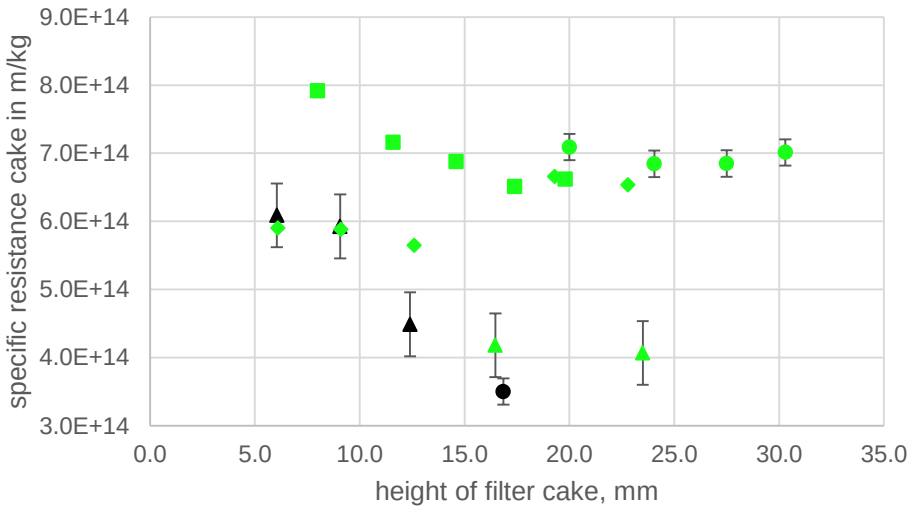
H = 15,6 mm

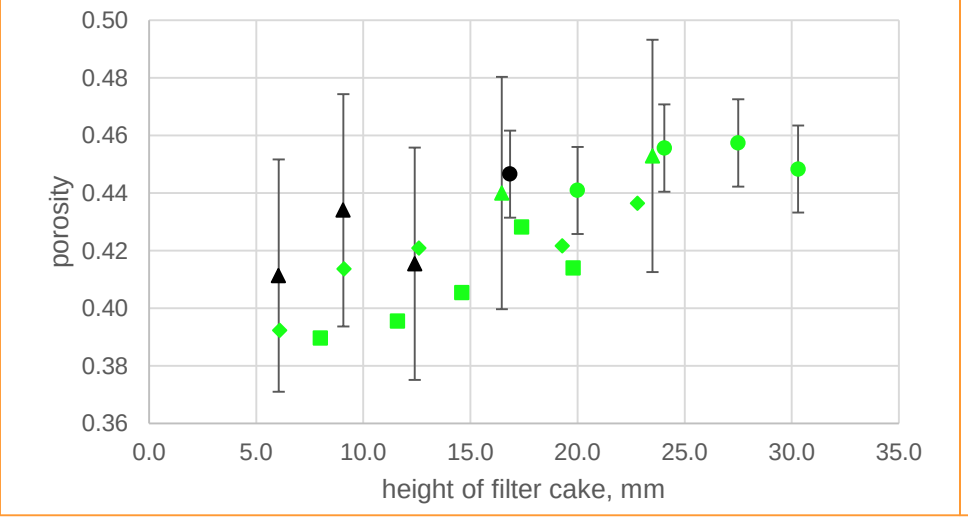
H = 28,9 mm

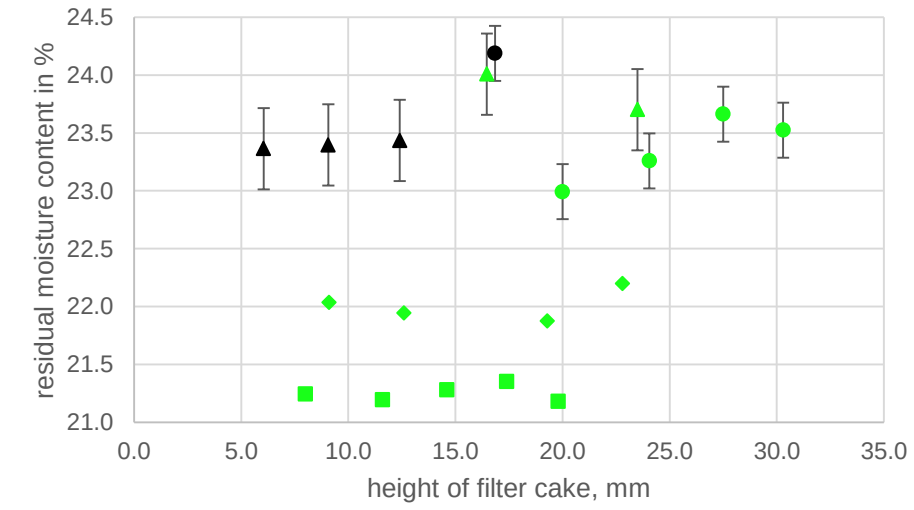
3. Results and discussion with limestone

Effect of height of filter cake on crack formation for KS12









Effect of height of filter cake on crack formation for KS12

Cv =0.3 ΔP = 3 bar H = 15,6 mm	Cv =0.3 ΔP = 3 bar H = 19.8 mm	Cv =0.2 ΔP = 1 bar H = 16.5 mm	Cv =0.2 ΔP = 1 bar H = 23.5 mm

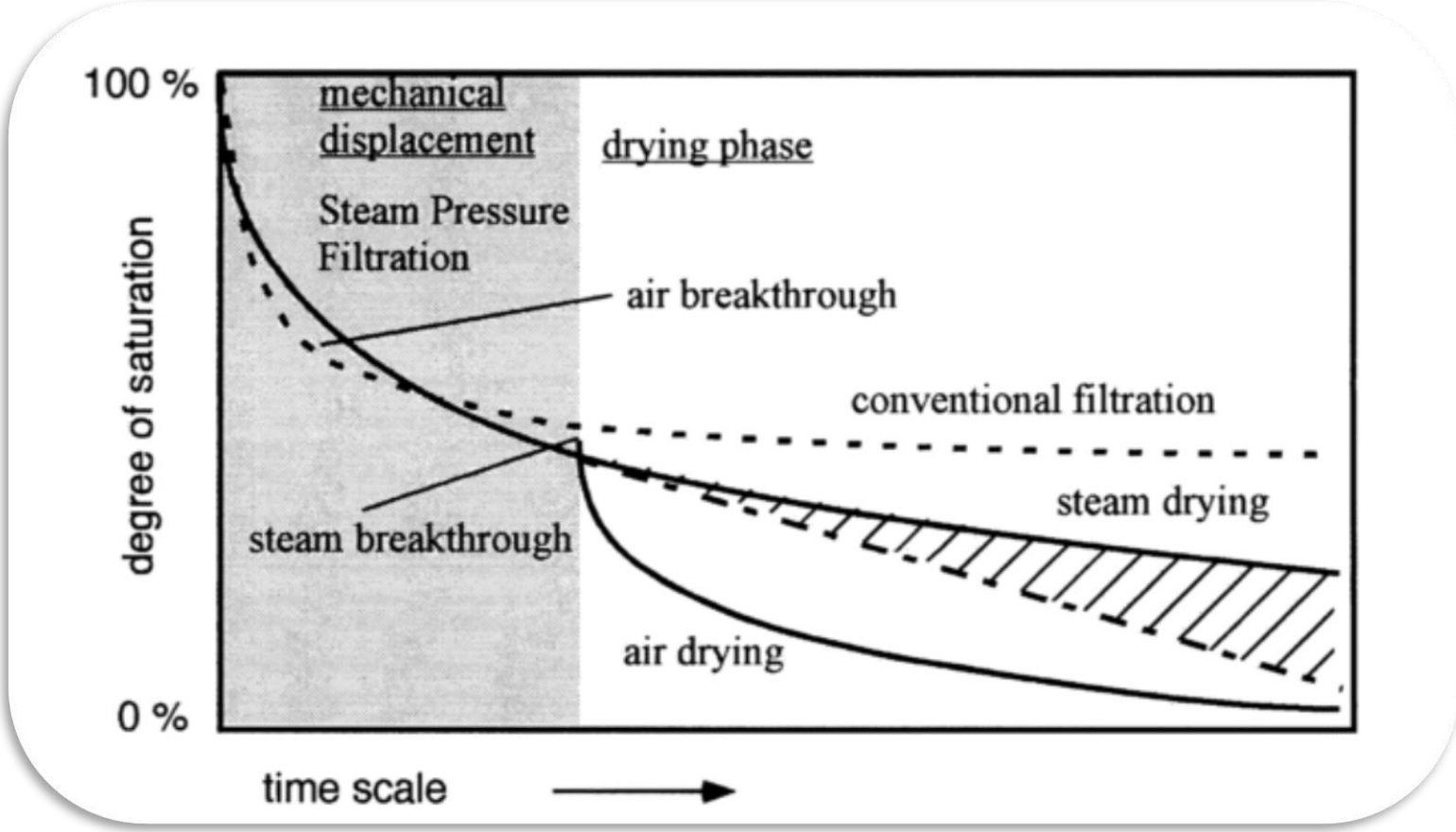
4. Next steps...

Using steam pressure filtration as a new method to reduce the degree of crack and improve dewatering

Steam pressure filtration

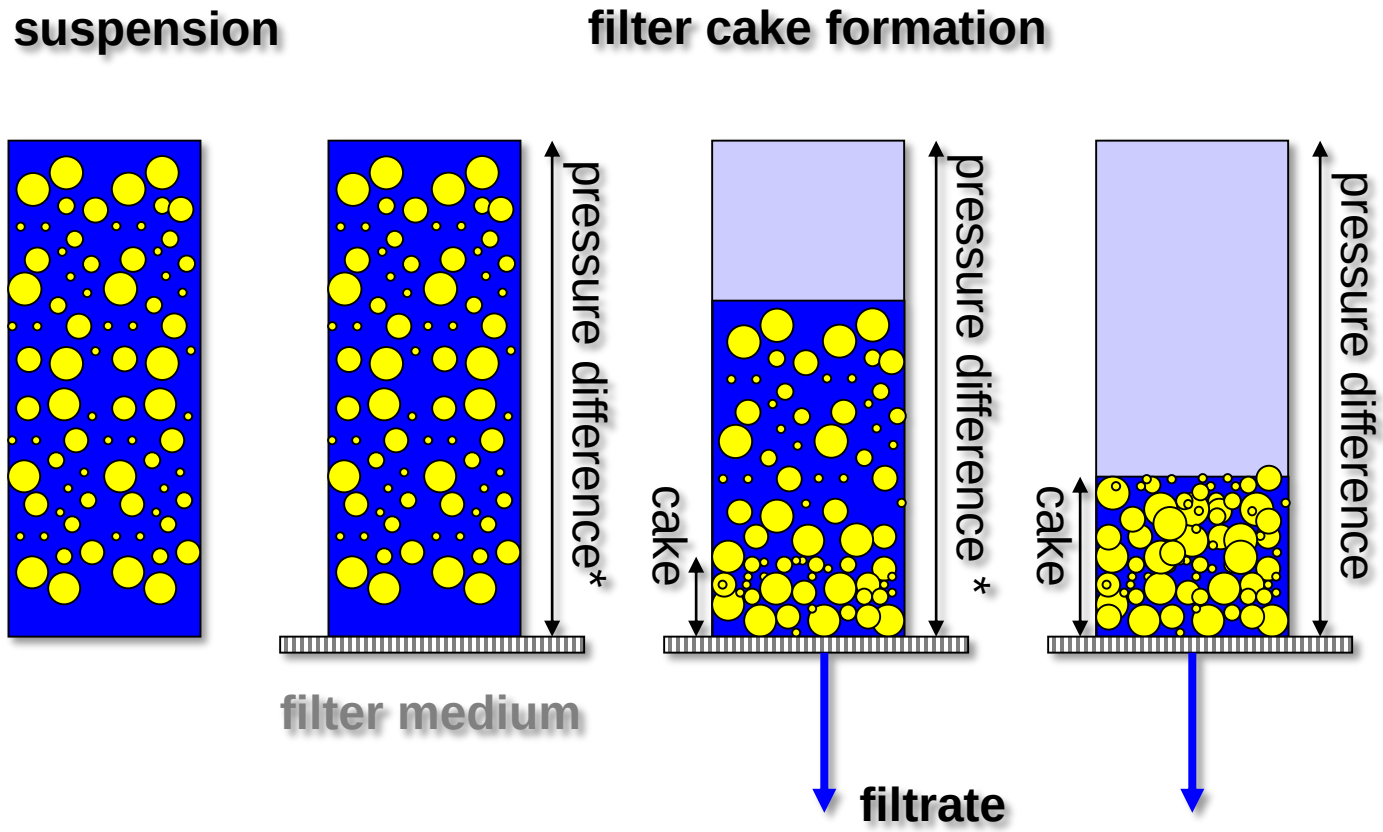
- ***Tensile strength*** *on filter cake could be higher than that of normal filtration.*
- ***Surface tension****, capillary force could be lower in high temperature.*
- *Mother liquor in big pore and small pore can flow simultaneously out of filter cake. Therefore, saturation is lower and* ***residual moisture content of filter cake can be improved***

Using steam pressure filtration as a new method to reduce the degree of crack and improve dewatering



Stahl, U. A. P. a. W. (2001). STEAM PRESSURE FILTRATION:MECHANICAL-THERMAL DEWATERING PROCESS. DRYING TECHNOLOGY.: 807–848.(Stahl 2001)

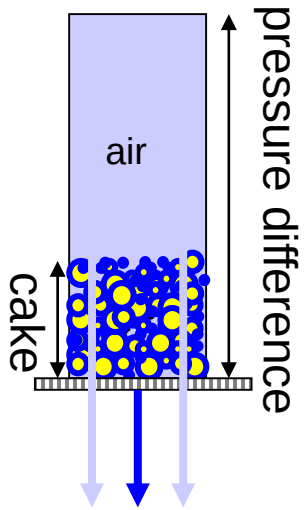
Using steam pressure filtration as a new method to reduce the degree of crack and improve dewatering



Technological principles and trends of mechanical solid-liquid separation technology. Prof.Dr.-Ing.Urs A.Peuker. Slide 6

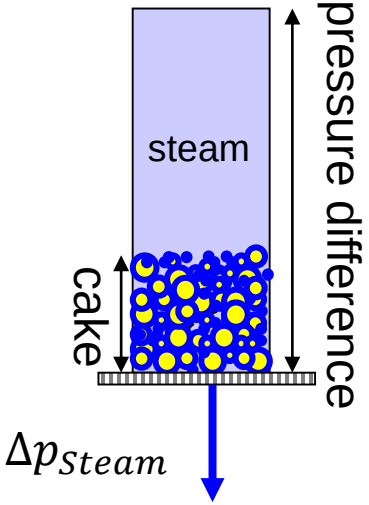
Using steam pressure filtration as a new method to reduce the degree of crack and improve dewatering

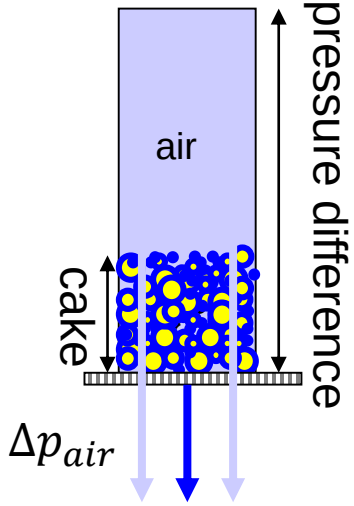
Mechanical displacement and drying with air

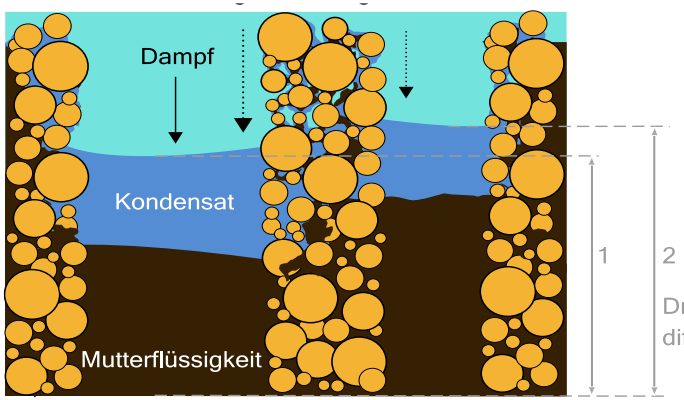


Conventional filtration

Mechanical displacement with steam and drying with air

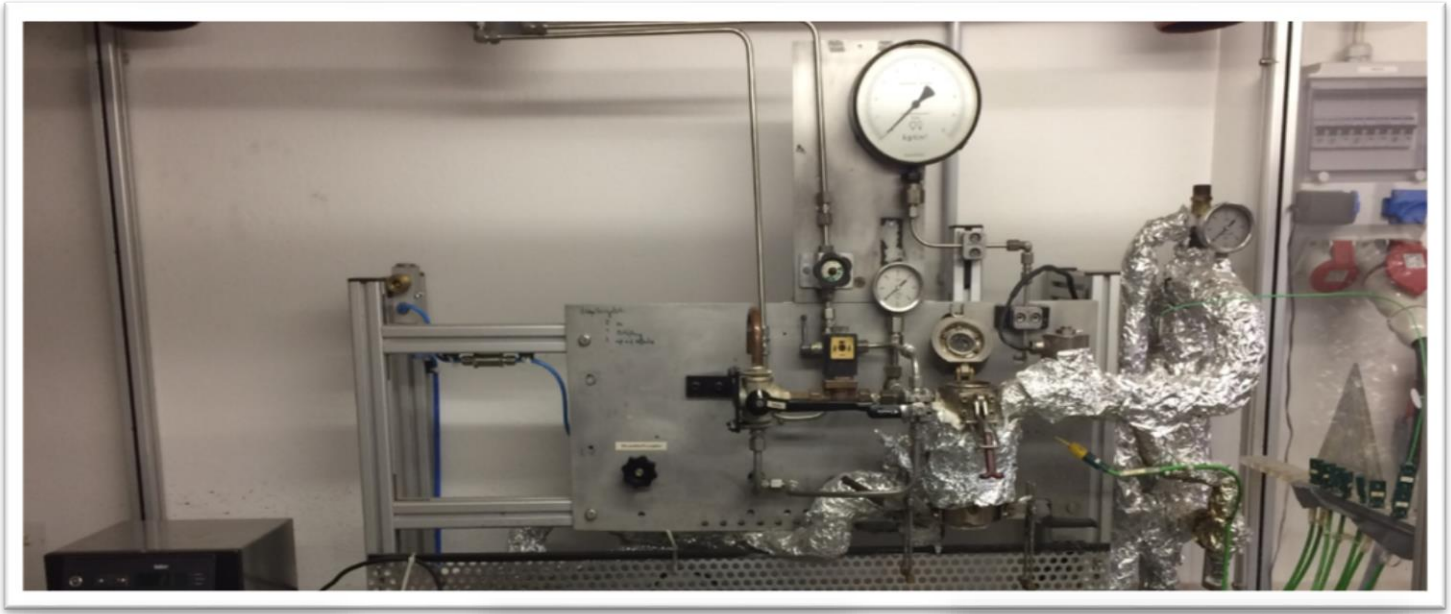




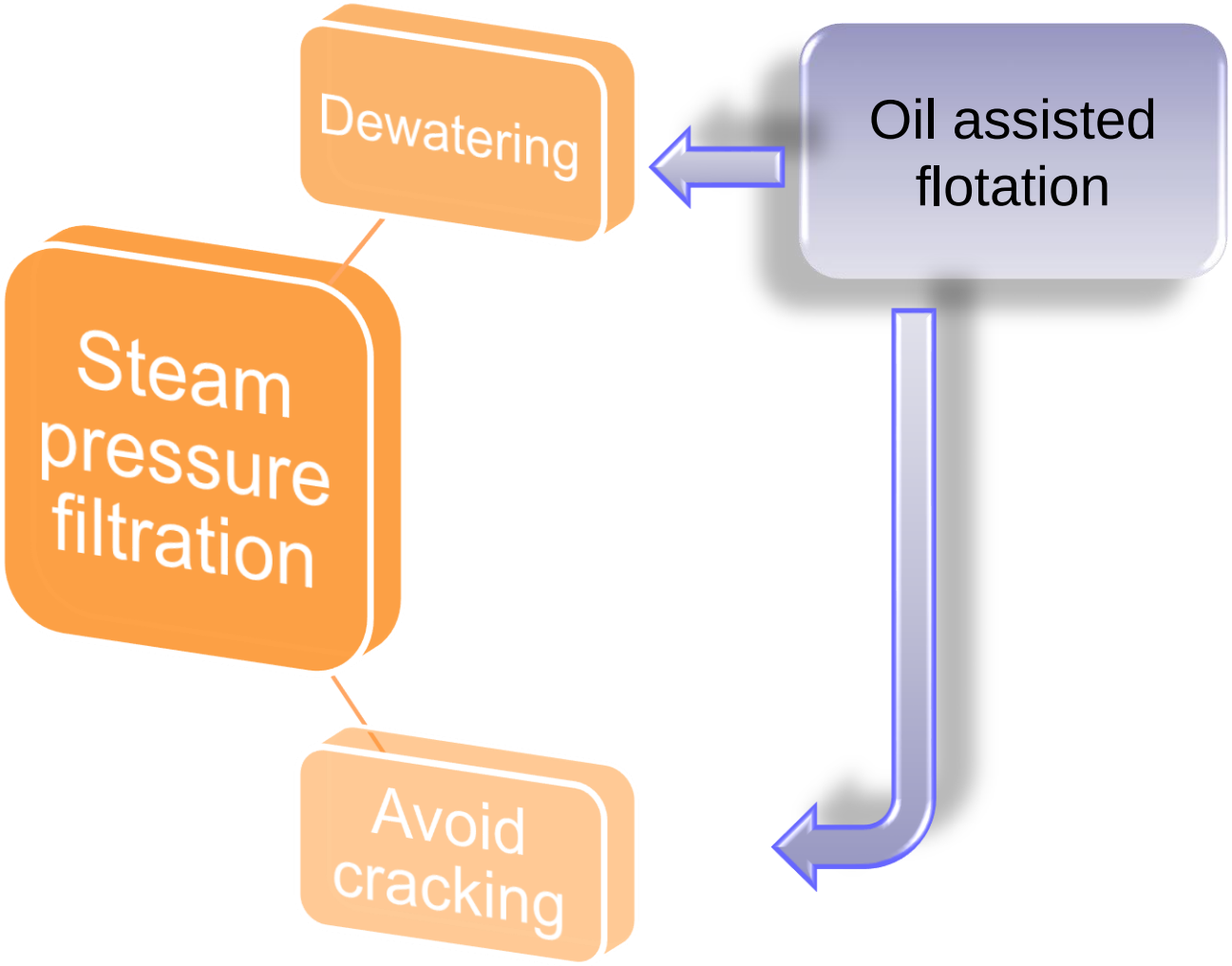


Steam pressure filtration

Lab - scale steam pressure filtration equipment



Next tests...


Oil assisted flotation
Dewatering
Steam pressure filtration
Avoid cracking

Thank you for your attention!

MSc. Thanh Hai Pham
PhD student at Institute of Mechanical Process Engineering and mineral Processing
TU Bergakademie Freiberg, Germany