Vortrag

Freitag, 06. Oktober 2023, 09:30 Uhr

“Wie und warum soll Bohrspülung bei HDD recycelt werden”

Vortragender: Renzo Chirulli, Paolo Posocco, Wladimir Galjard
Firma: Vermeer EMEA, ANESE Srl, Galjard Bau GmbH
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Lecture

Friday, 06th October 2023, 09:30 am

“How and why to recycle drilling mud in horizontal directional drilling operations”

Speaker: Renzo Chirulli, Paolo Posocco, Wladimir Galjard
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How and why to recycle drilling mud in horizontal directional drilling operations

27th DCA Annual Congress – Leipzig, Germany

Paolo Posocco, Project Manager - ANESE Srl, IT
Wladimir Galjard, Geschäftsführer - Galjard Bau GmbH, DE
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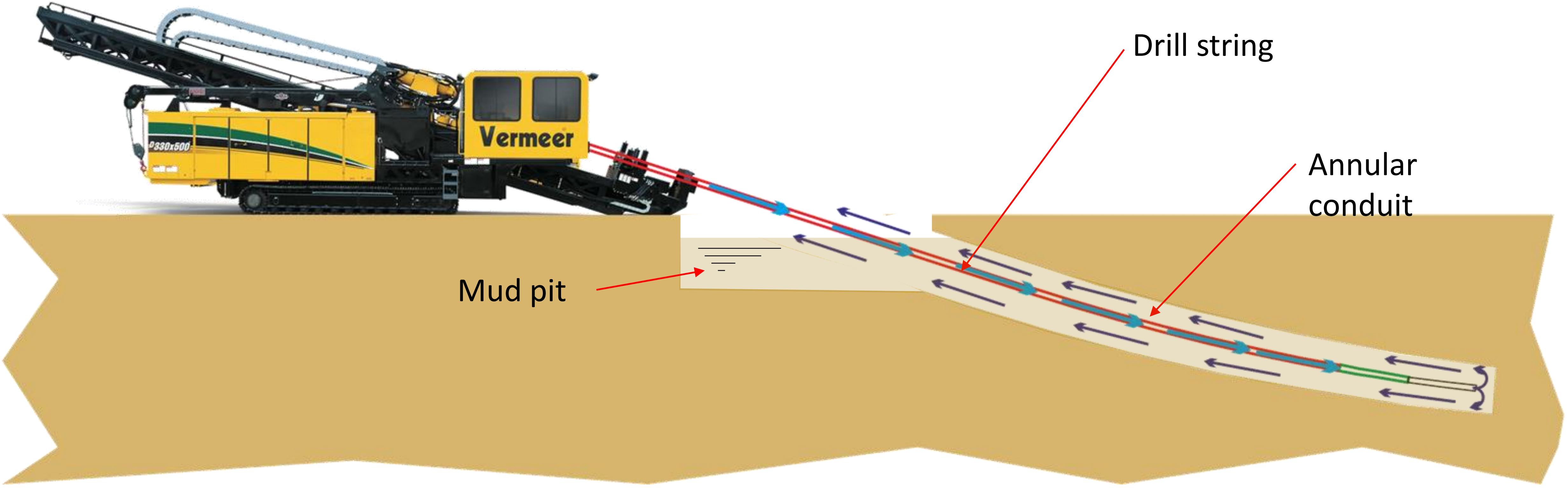
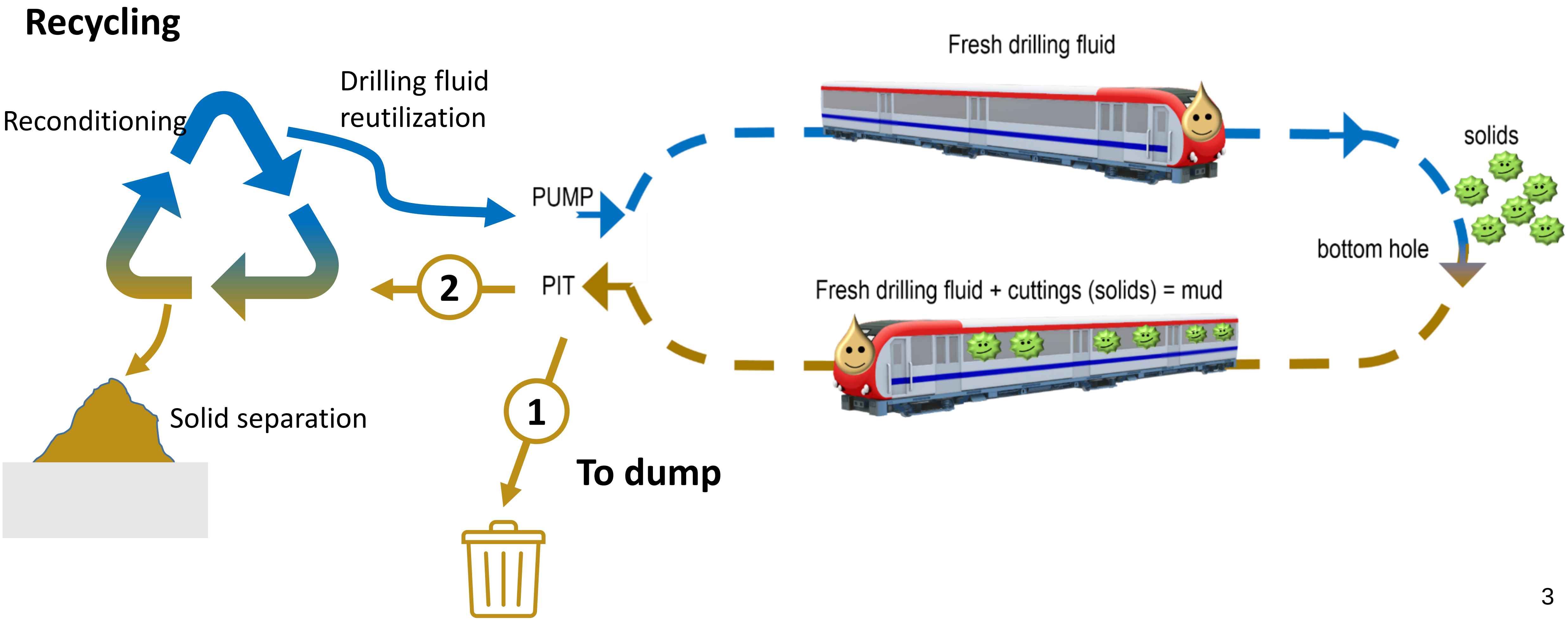
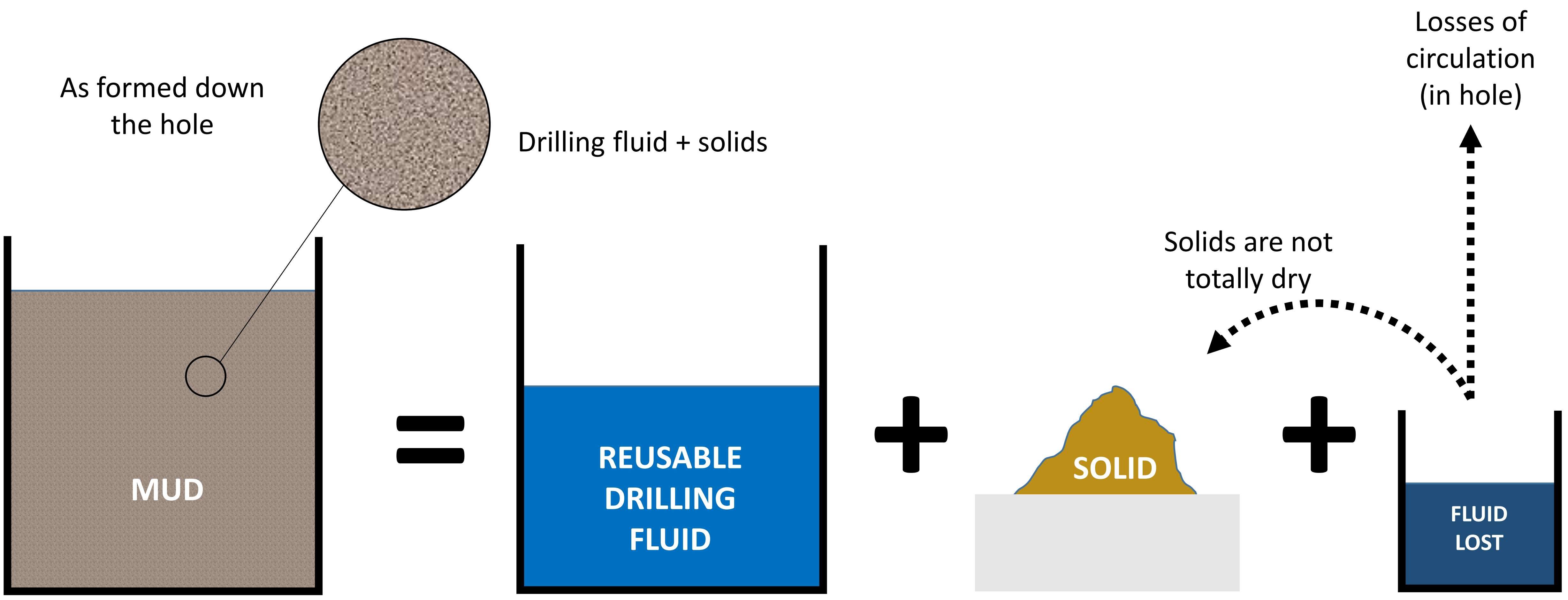
Circulation of drilling fluids



What does it mean “mud recycling”?
The fluid train

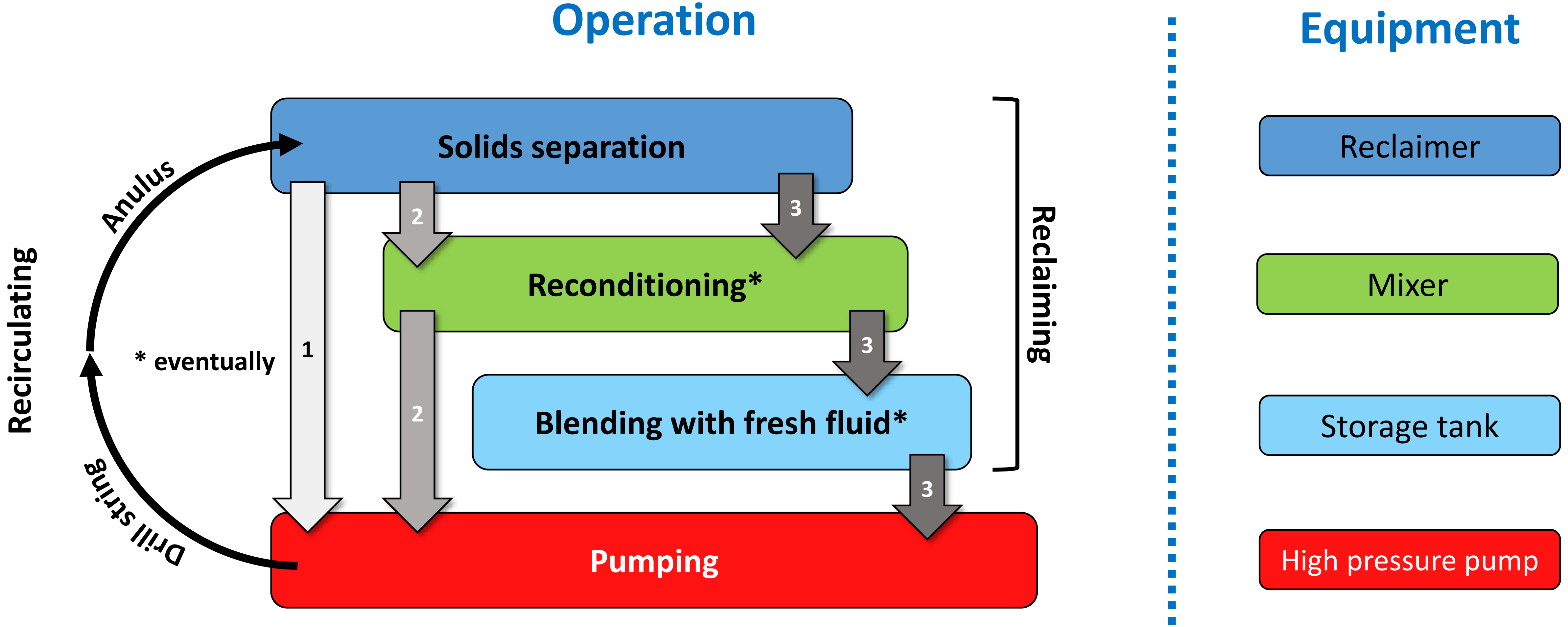


Solid separation

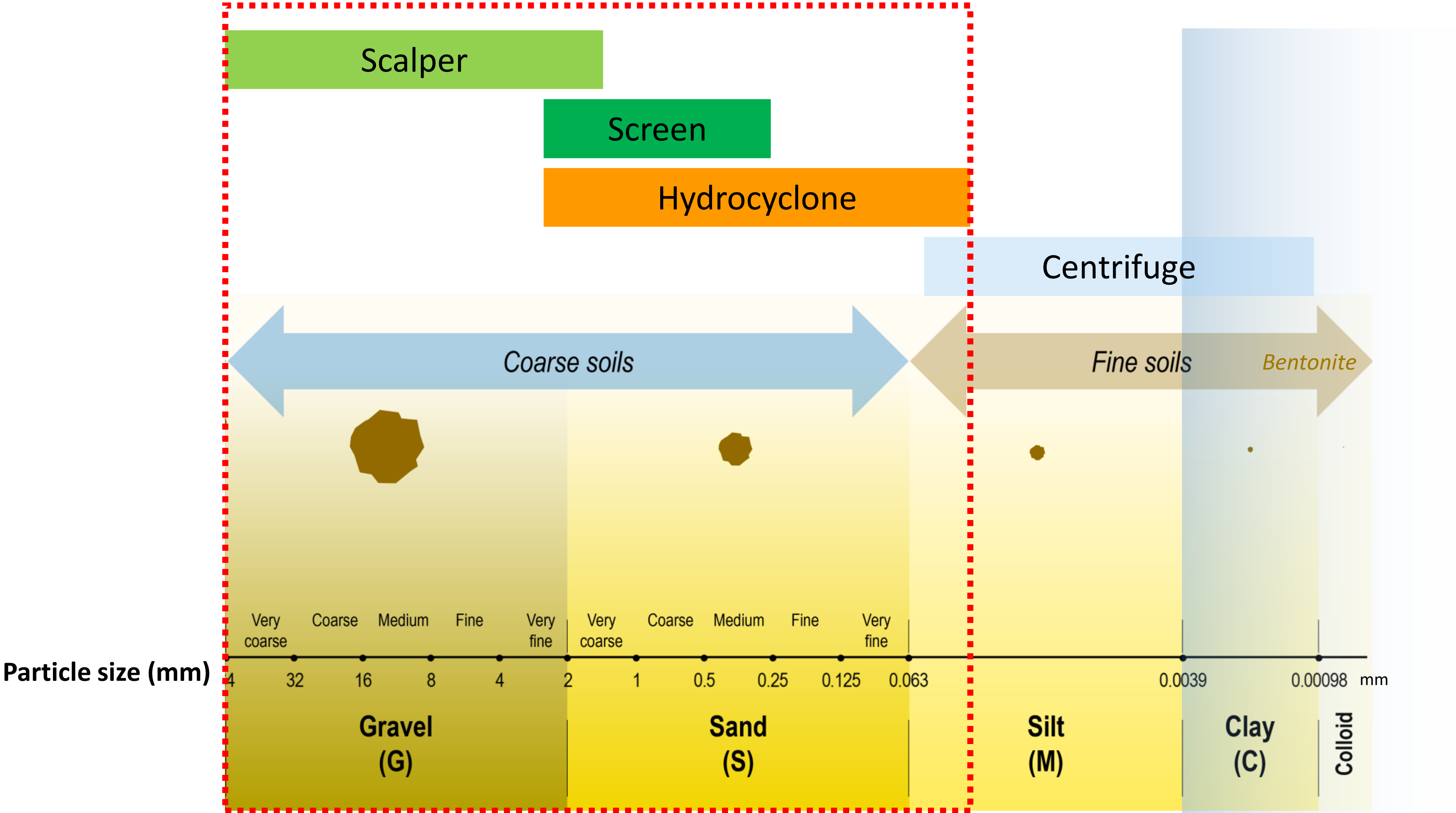


Mud recycling

Recycling = reclaiming + recirculating



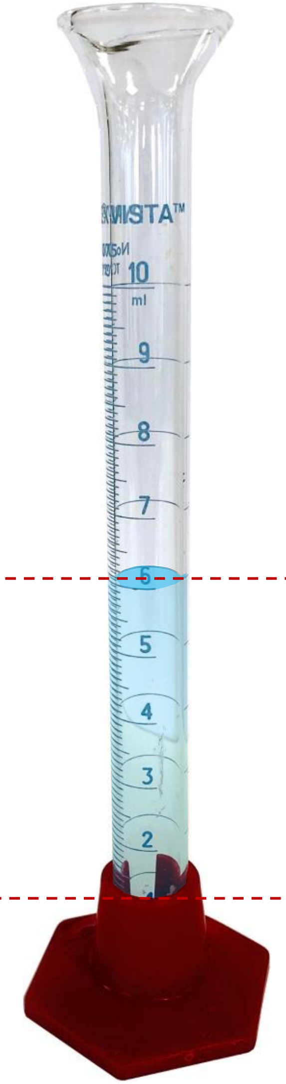
Solid separation



Volumetric solid content %

Detrimental solids = soil cuttings

Useful solids = bentonite



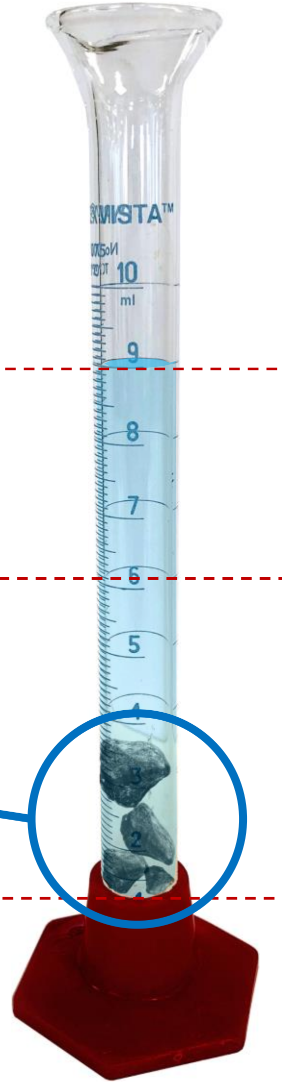
V_f

Fluid volume = V_f

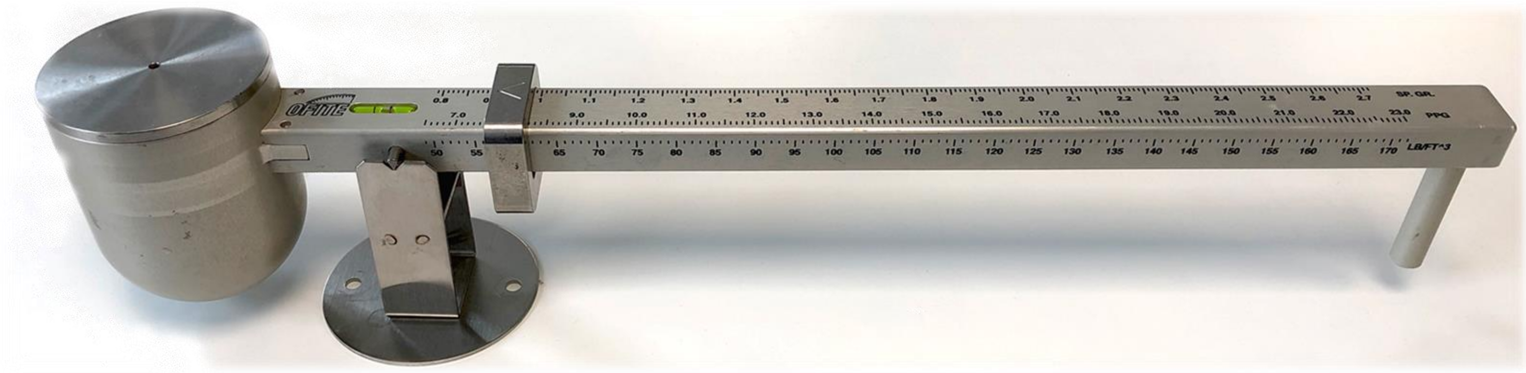
$V_f + V_s$

Solid volume = V_s

Solids = “passengers”



How to measure the solid content?

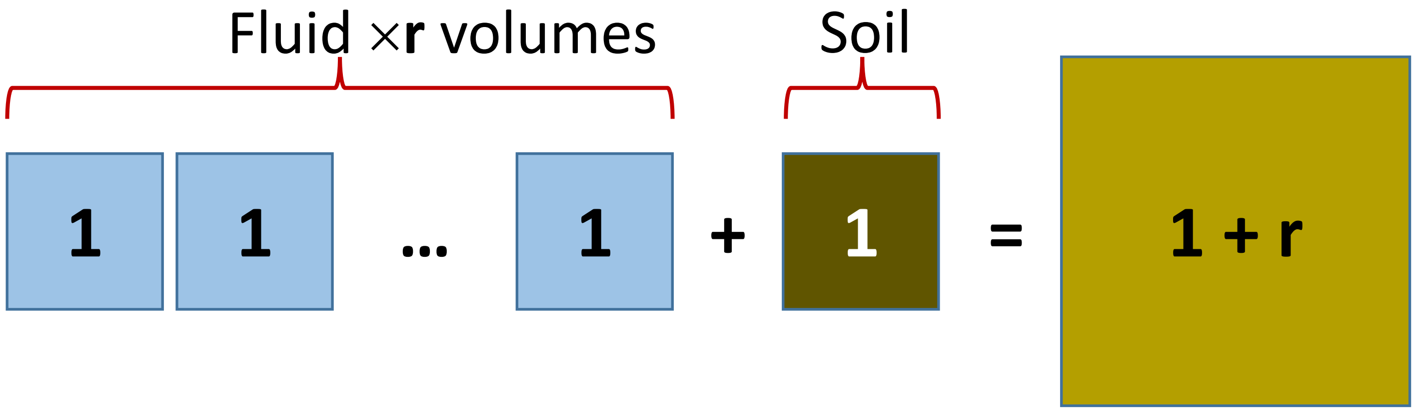


$$SC\% = \frac{SG_m - SG_{fm}}{\sim 1.6} \times 100\% = (SG_m - SG_{fm}) \times 62.5\%$$

In water-based drilling mud:

SC% = 9% - 33%
Drilling fluid/soil ratio: **r = 10 - 2**

The fluid factor



Drilling fluid to soil ratio or **fluid factor – r**

$$SC\% = \frac{1}{1+r} \times 100\%$$

$$SG = \frac{SG_s \times 1 + SG_{fm} \times r}{1+r}$$

Where:
SG_S = Specific gravity of solids
SG_{fm} = Specific gravity of fresh mud

The fluid factor

Another way to define the fluid factor **r** is the following:

$$\boldsymbol{r} = \frac{F}{ROP_V}$$

Where:

F = high-pressure mud pump flow rate (m³/min)

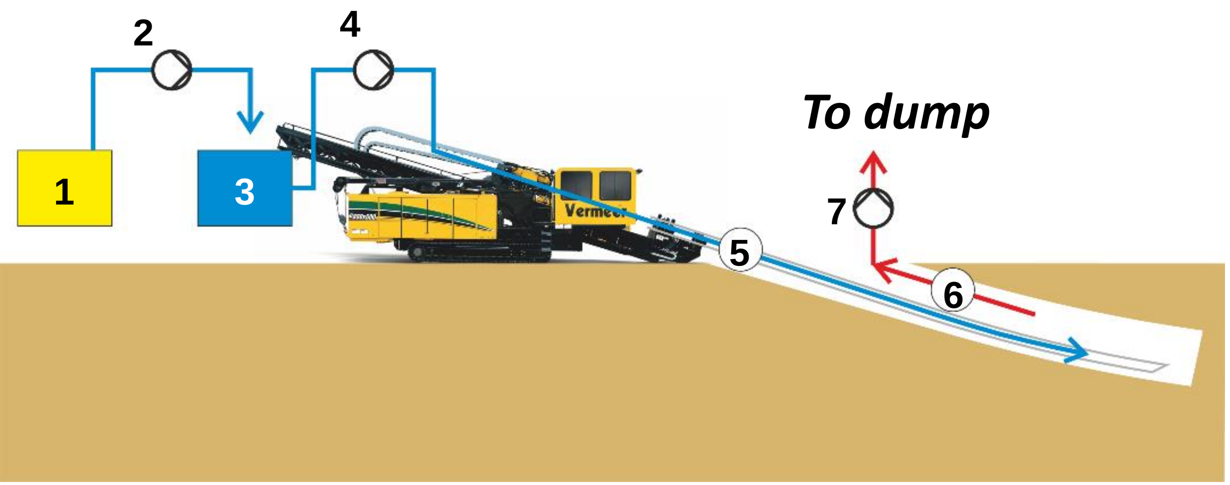
ROP_V = Volumetric rate of penetration (m³/min) = $\dfrac{ROP \times (D_H^2 - D_R^2)\pi}{4}$

ROP = Rate of penetration/reaming (m/min)

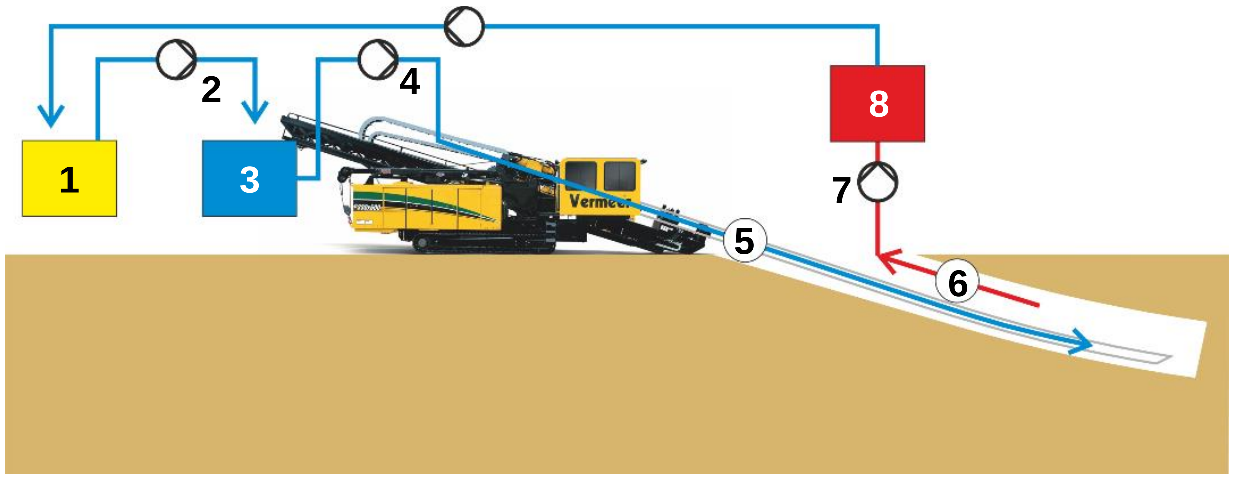
D_H = current reaming diameter; D_R = pre-reaming diameter; in pilot bore D_R = 0

The fluid circuit: open versus closed

Open circuit = to dump



Closed circuit = recycling



LEGENDA

1. Mixer
2. Transfer pump
3. Storage
4. High pressure pump
5. Drill pipes
6. Anulus
7. Pit pump
8. Reclaimer

One of the main differences between open fluid circuit and closed fluid circuit is the total volume of drilling fluid required to perform the same operations.

$$\mathbf{Volume_{OPEN} >> Volume_{CLOSED}}$$

Total fluid volume – OPEN CIRCUIT (no recycling)

$$VT_O = (V_S \times r) + V_P$$

Where:

VT_O = Theoretical total fluid volume in an **OPEN CIRCUIT** (without recycling)

V_S = Solid volume = $\frac{D_H^2}{4}\pi \times L_H \quad or \quad \frac{D_H^2 - D_R^2}{4}\pi \times L_H$

D_H = Hole diameter
D_R = Pre-ream diameter
L_H = Hole length
r = Fluid factor
V_P = pit volume

Total fluid volume – CLOSED CIRCUIT (perfect recycling)

$$VT_C = V_S + V_P$$

Where:

VT_C = Theoretical total fluid volume in a **CLOSED CIRCUIT** (perfect recycling)

V_S = Solid volume = $\frac{D_H^2}{4}\pi \times L_H \quad or \quad \frac{D_H^2 - D_R^2}{4}\pi \times L_H$

D_H = Hole diameter
D_R = Pre-ream diameter
L_H = Hole length
r = Fluid factor
V_P = pit volume

Actual Total fluid volume – Closed circuit (actual recycling)

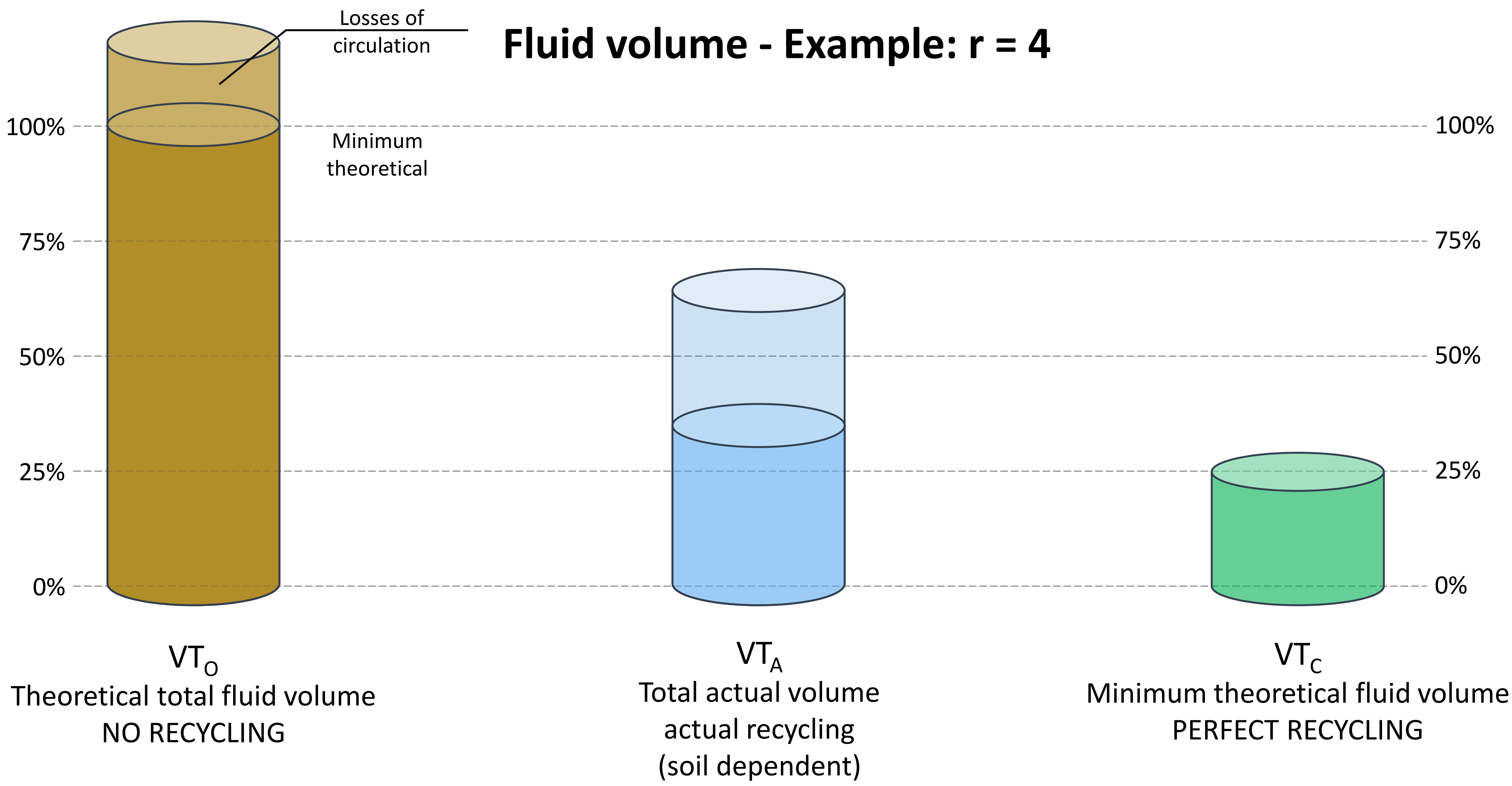
$$VT_C < \mathbf{VT_A} < VT_O$$

Where:

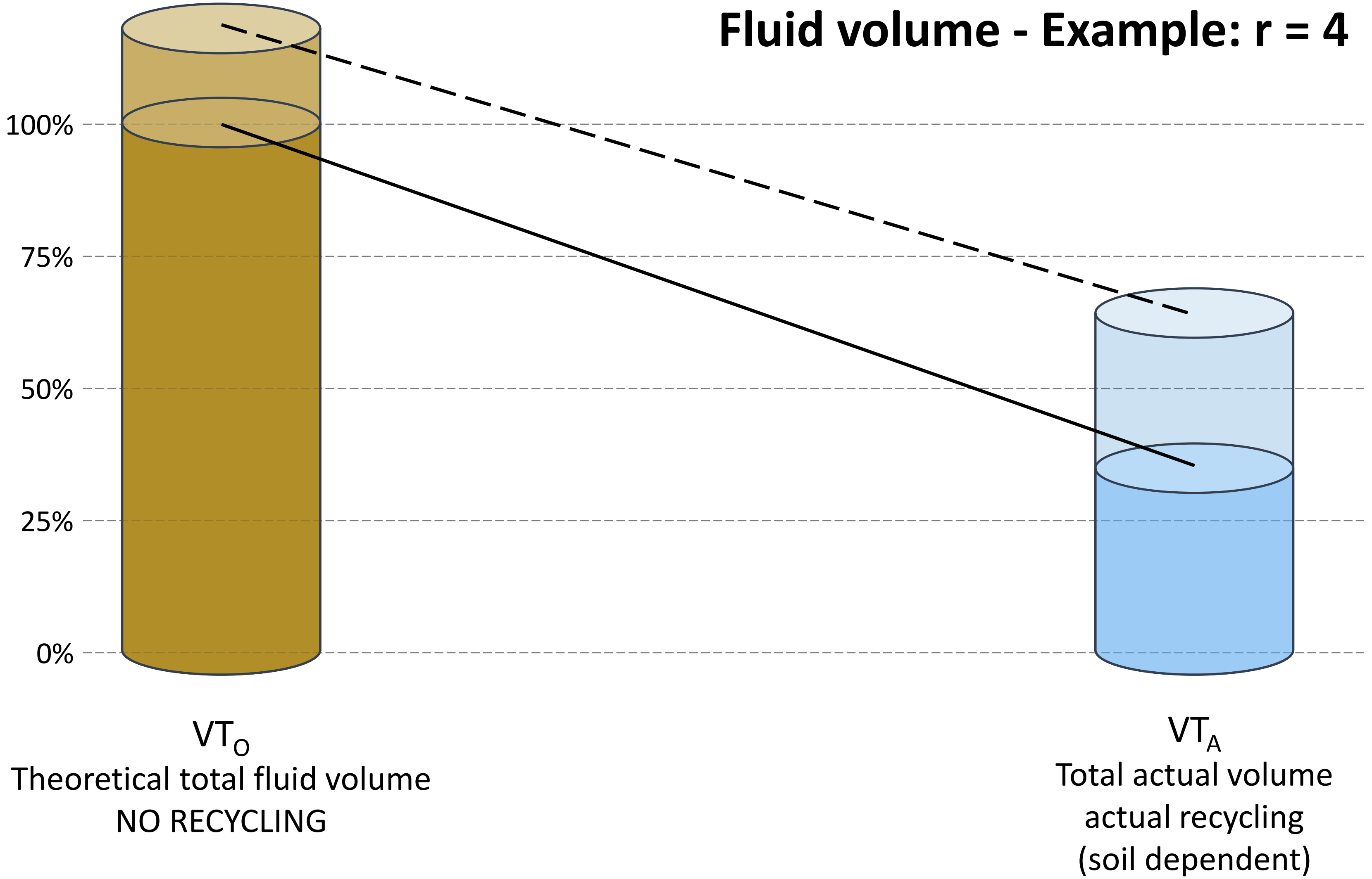
VT_A = Actual total fluid volume in a closed circuit (actual recycling)

Why recycling?

Fluid volume - Example: r = 4



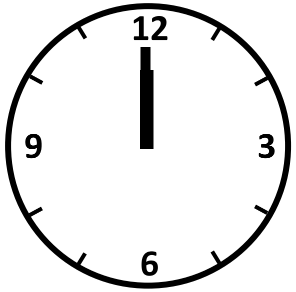
Why recycling?



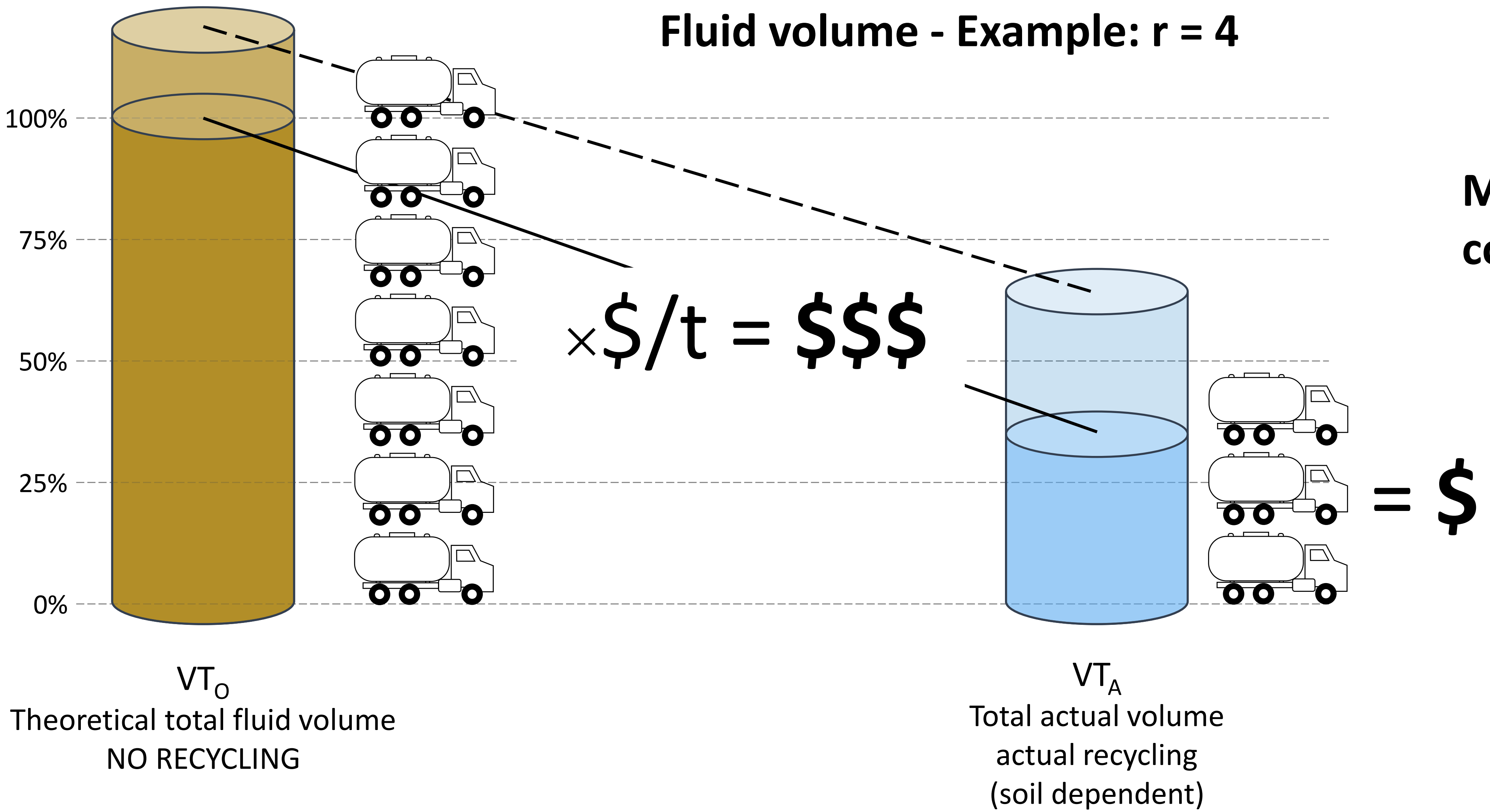
When recycling, less:

- Make up water
- bentonite
- additives
- energy

Less overall mixing time



Why recycling?



Minimize disposal costs when recycling.

Recycle or not recycle?

Recycle when:

- Using drilling fluid predominantly made with bentonite
- It is convenient to reduce the whole amount of drilling fluid utilized during drilling/installation
- Undergoing strict disposal regulations and significant disposal costs
- Water is a scarce/expensive resource
- It is convenient to minimize job site storage area for water/bentonite
- It is convenient to optimize job site logistic (e.g., by reducing vacuum and tank trucks travels)
- It is convenient to maximize the rate of operation (drilling, reaming)

Do not recycle when:

- Using long-chain polymers (e.g., long-chain PHPA)
- Costs of disposal of the exhaust mud are low to very low

How to measure the efficiency of recycling

Saving factor:

$$S_f = \frac{VT_O - VT_A}{VT_O} \times 100\%$$

Represents the percentage of fluid volume saved in comparison with the theoretical total volume in case of open fluid circuit (no recycling).

Recycling factor:

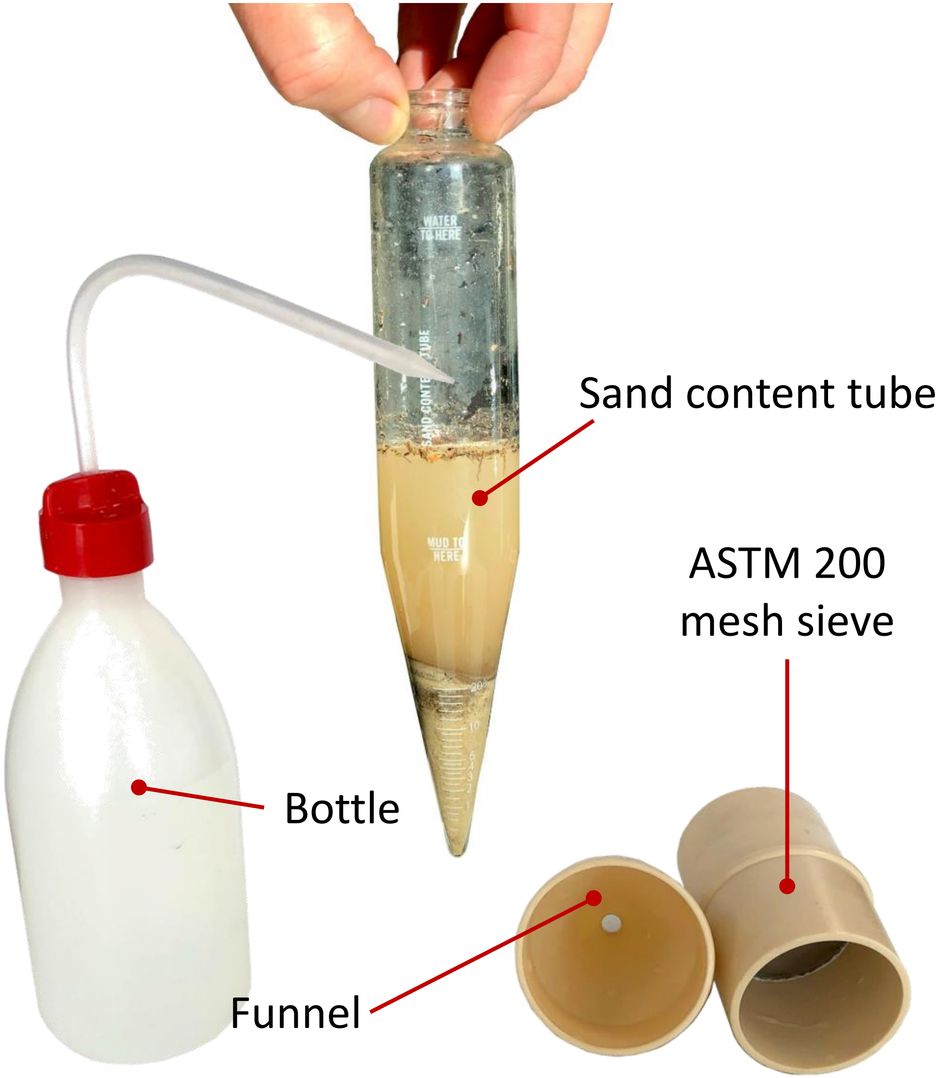
$$R_f = \frac{V_S}{VT_A} \times 100\%$$

R_f = 100% represents the perfect recycling ($VT_A = V_S$). While VT_A increases, the recycling factor decreases.

Sand content

The solid fraction which includes sand and coarser particles must be removed from the fluid when recycling, because it is extremely detrimental for the HDD equipment.

When recirculating the fluid into the mud pump, the sand content should be less than **0.5% - 0.25%** in order to help avoid excessive pump wearing.

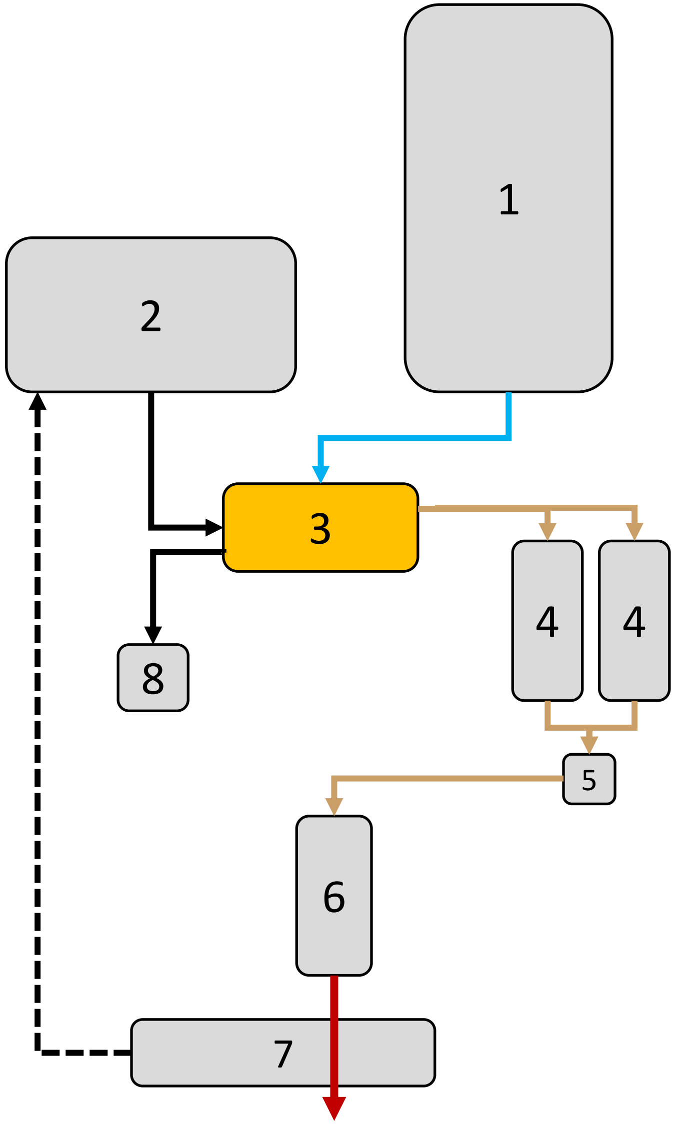


Case history #1 – ANESE Srl, IT

Vermeer MR2000 fully electric combined mixer/reclaimer

Closed circuit

1. Fresh water storage
2. Mud pool
3. MR2000 mixer/reclaimer
4. Clean mud - Storage tank
5. High-pressure pump
6. Drill rig
7. Mud pit
8. Solid dump



Vermeer MR2000 fully electric combined mixer/reclaimer

PROJECT INFORMATION:

Installation: Gas distribution

Pipe material: Steel

Soil condition: fine soil

Bore length - $\mathbf{L_H = 500\ m}$

Final bore diameter - $\mathbf{D_H = 800\ mm}$

VOLUMES:

External fresh drilling fluid storage tank volume = 40 m^3

External mud pit volume $\mathbf{V_P = 60\ m^3}$

Soil volume - $\mathbf{V_S = 250\ m^3}$

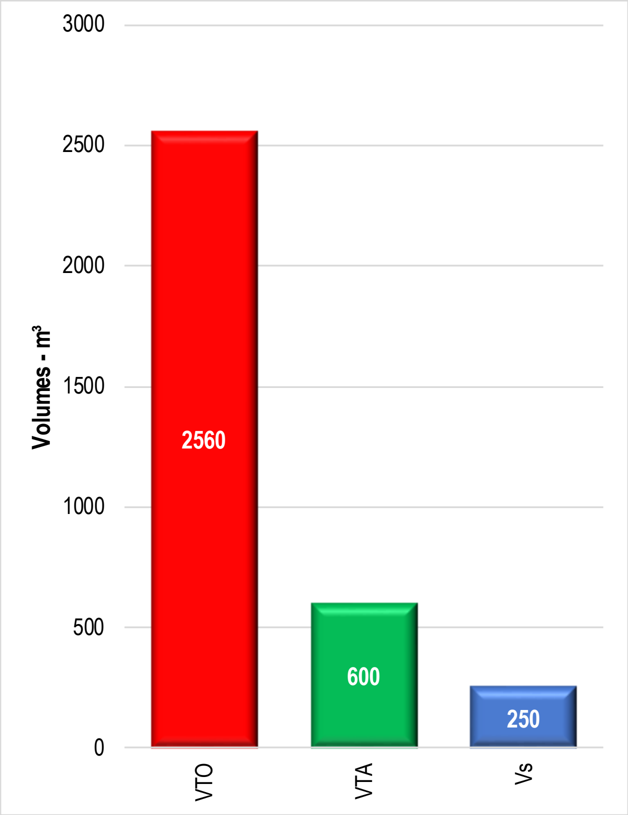
Fluid factor - **r = 10**

Actual total fluid volume in the closed circuit - $\mathbf{VT_A = 600\ m^3}$

Theoretical total fluid volume in an open circuit (no recycling: $VT_O = V_S \times r + V_P = \mathbf{2560\ m}^3$

Saving factor: $S_F = \dfrac{VT_O - VT_A}{VT_O} \times 100\% = \mathbf{77}\%$

Recycling factor: $R_f = \dfrac{V_S}{VT_A} \times 100\% = \mathbf{42}\%$



Sand content after reclaiming:
≤ 0,25%

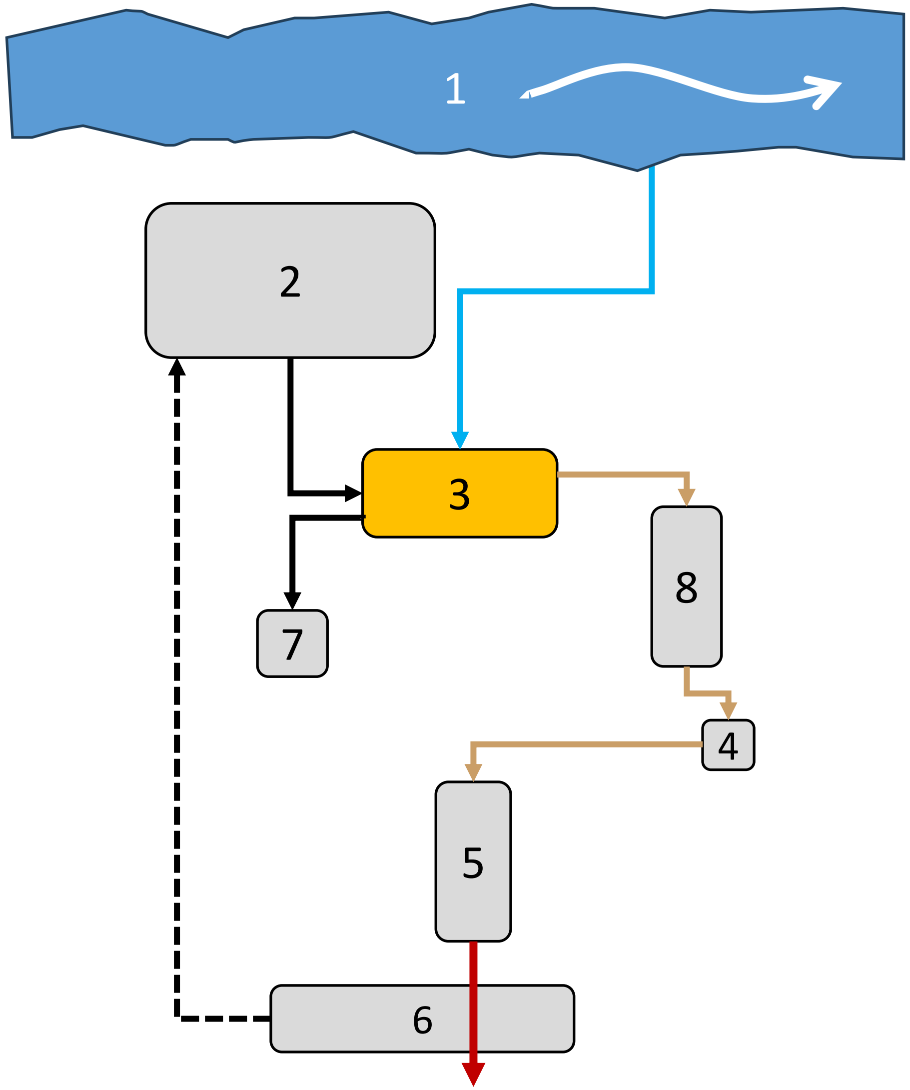
Vermeer MR2000 fully electric combined mixer/reclaimer

Case history #2 – Galjard Bau GmbH, DE

Vermeer MR1000 fully electric combined mixer/reclaimer

Closed circuit

1. Fresh water source (river)
2. Mud pool
3. MR1000 mixer/reclaimer
4. High-pressure pump
5. Mud pit
6. Drill rig
7. Solid dump
8. Fluid storage (no pictures)



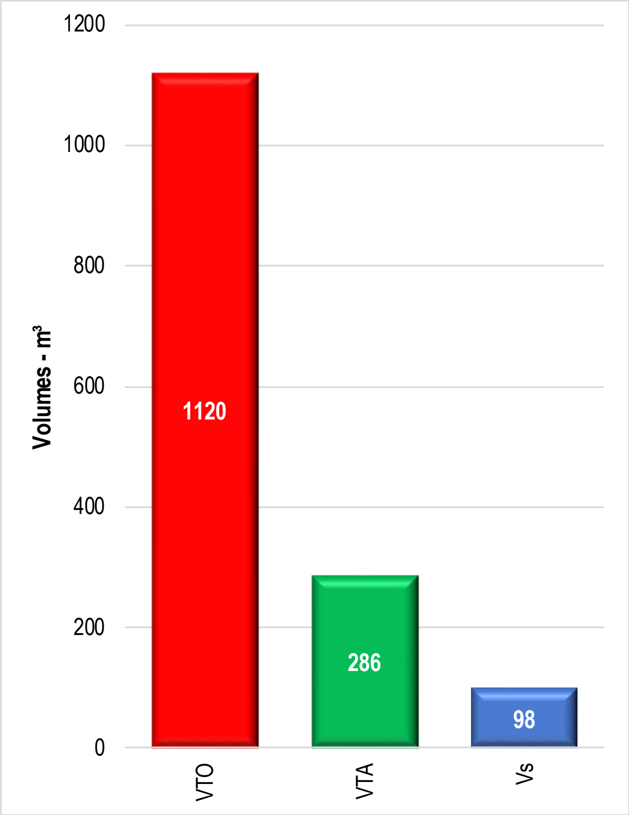
Vermeer MR1000 fully electric combined mixer/reclaimer

PROJECT INFORMATION:
Installation: medium-voltage cables for the South Eifel solar park
Pipe material: HDPE 2×DN160 + 1×DN140
Soil condition: shale
Bore length - L_H **= 500 m**
Difference in elevation (entry-exit): **180 m**
Final bore diameter - D_H**= 500 mm**

VOLUMES:
External fresh drilling fluid storage tank volume = 30 m^3
External mud pit volume V_P **= 1×20 + 2×60 = 140 m³**
Soil volume - V_S **= 98 m³**
Fluid factor - **r = 10**
Actual total fluid volume in the closed circuit - VT_A **= 286 m³**
Theoretical total fluid volume in an open circuit (no recycling: $VT_O = V_S \times r + V_P$=**1120 m³**

Saving factor: $$S_F = \frac{VT_O - VT_A}{VT_O} \times 100\% = \mathbf{74}\%$$

Recycling factor: $$R_f = \frac{V_S}{VT_A} \times 100\% = \mathbf{34}\%$$



Vermeer MR1000 fully electric combined mixer/reclaimer

Sand content after reclaiming:
≤ 0,25%

Thank you!