12th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2008, Istanbul, Turkey, 26-30 August, 2008

ECOLOGICAL OPTIMUM OF USING WATER FROM AN OPEN STREAM

Ph.D. Omer Jukić, Assis. Professor, B.Sc.Mech.Eng.,
Rudnik mrkog uglja "Kakanj", d.o.o.
A. Izetbegovića 17 – 72240 Kakanj, B&H

ABSTRACT
Truck transport of run-of-mine and commercial mine from pits, preparation plants and surface mines, by local and main roads, results in significant dusting of the environment during dry seasons and increased mud quantities during wet seasons.
In order to solve this problem, it is necessary to construct a washing plant for automated washing of freight vehicles and provide filtrated water from an open stream. This would result in clean vehicles on roads. Water used for washing would be treated in a treatment plant and discharged back into the river. All the plants would be automated, not requiring manpower.
Keywords: pump, filter, pipeline, tank, nozzles, photo-cell, sedimentation tank, oil separator

1. INDUSTRIAL WATER SUPPLY LINE
Centrifugal pump takes water from an open water stream and routes it to a filter which separates all the particles above 100 μm and directs them into a contamination sedimentation tank, through a filter and into reservoirs, An appropriate filtration technology was selected, based on the stream water analysis. A 100 μm sieve filter is used. The filter technology is based on fully automated operation.

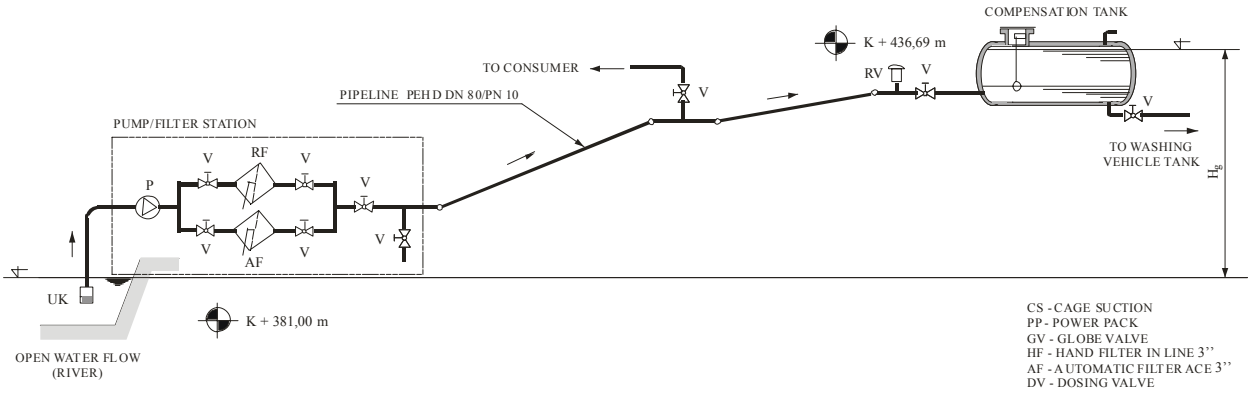

Figure 1. Layout: Industrial water supply line taking water from an open stream

1.1. Required pump pressure

$$H_P = \left(\lambda \frac{L}{D} + \sum \xi_i \right) \frac{v^2}{2g} \gamma + \gamma H_g \ \text{[kPa]} \qquad \text{... (1)}$$

λ - friction coefficient in the pipeline
L [m] - pipeline length
D [m] - pipeline diameter
ξ_i - local resistance coefficient
v [m/s] - water flow velocity in the pipeline
γ [N/m^3] - water volume weight

1.2. Pipeline characteristics

In order to fit the pipeline into the pump, a curve "pipeline characteristics" need to be constructed and pump operation point determined.

Pipeline characteristics are given in the following equation:

$$H = m Q_P^{\,2} + \gamma H_g \text{ [Pa]} \quad \ldots (2)$$

Q_P [m^3/s] - required pump capacity

$$m = \frac{\sum h_W}{Q_P^{\,2}} \text{ [Ns}^2\text{/m}^8\text{]} \text{ - pipeline constant} \quad \ldots (3)$$

$\sum h_W$ [kPa] - total pressure decrease in the pipeline

2. FREIGHT VEHICLE WASHING PLANT

Truck transport of run-of-mine and commercial mine from pits, preparation plants and surface mines, by local and main roads, results in significant dusting of the environment during dry seasons and increased mud quantities during wet seasons. In order to solve this problem, it is necessary to construct a facility and install a Plant for automated washing of freight vehicles (Washing Plant). This would result in clean vehicles on roads. The plant would be automated, not requiring manpower. Vehicles entering the plant would activate its operation through photo-cells. Once washing is complete, the plant would turned off in the same manner. The automated operation would be used only for the lower part of pipe network, i.e. for operation of one pump power unit and washing of the lower part of a freight vehicle. The Washing Plant would be supplied with water from an industrial water supply system, through a pipeline PEHD DN 150/PN 10 and pump power units.

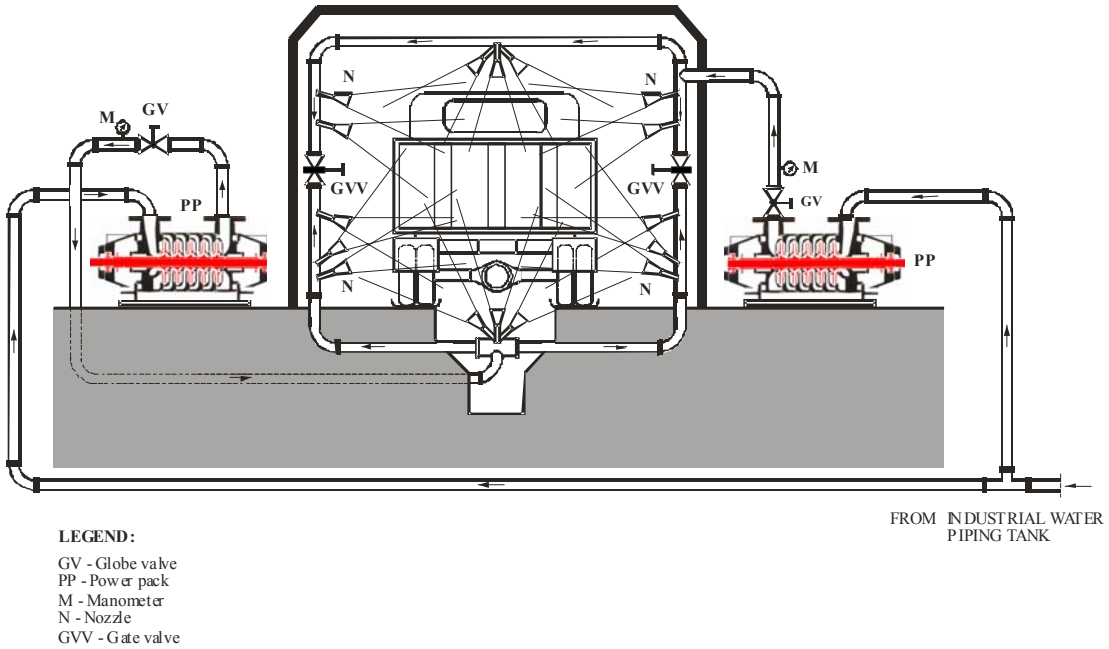

Figure 2. – Layout: Automated washing plan for freight vehicles

2.1 Dimensioning criteria

2.1.1. Elements

Experiential criteria:

- Washing platform, length: L = 3,65 m (12 feet)
- Nozzles angle: α = 45º, in relation to wheel rotation direction
- Vehicle speed on the platform: v = 9,14 ÷ 12,19 m/min (30 ÷ 40 feet/min)
- Water pump capacity: Q = 1.287 l/min (340 GPM), unit
  Q = 3.028 l/min (800 GPM), for simultaneous work
- Water pressure in the installation: p = 2,72 bar (40 PSI), constant
- Electro motor power: N = 14,9 kW (20 HP), spare power min.15%
- 100% covering of vehicle surface by water beam from nozzles required

2.1.2. Concept

- Maximum length of vehicle with trailer: L_{max} = 20 m
- Covering area of water beam from nozzles: Q = a x b x h = 6,0 x 3,5 x 4,0 [m^3]

2.2. Preliminary dimensioning

2.2.1 Washing process duration

$$t_p = \frac{L_{uk}}{v_v} \text{ [min]} \qquad \ldots (4)$$

$L_{uk} = L_p + L_{max}$ [m] - total length of vehicle

$L_p = 6{,}0$ m - length of the path crosses by vehicle in active washing process

$v_v = \min 9{,}0$ m/min - vehicle speed (speed of vehicle during washing process)

2.2.2. Pump capacity

Total water consumption in one washing cycle: Q = 1.287 l/min

$$V_v = Q \cdot t_p \qquad \text{max.[l/vehicle]} \qquad \ldots (5)$$

2.2.3. Selection of nozzles

p = 3,0 bars - pressure in the installation, constant

n [pcs.] - approximate number of nozzle on the washing platform

- average water consumption per nozzle in case of complete vehicle washing

$$q_{sp} = \frac{Q}{n} \left[\frac{\text{l/min}}{\text{nozzle}} \right] \qquad \ldots (6)$$

Nozzle type:

- Full cone nozzles
- Flat fan nozzles)

3. WASTE WATER FILTRATION PLANT

Raw waste water, water contaminated by motor oil and fecal water are directed into the plant for waste water filtration. This Plant consists of: two septic chambers, a biological chamber, disinfection pool (chlorine pool) and compressor station. The concept is based on two basic filtration procedures: mechanic (anaerobic) and biological procedure (aerobic, by active oil). This way, organic contamination is reduced for more than 90% in comparison to raw waste water contamination. Plant capacity would depend on the number of staff (biological and hydraulic burden) – quantity of fecal water and average production of other waste waters. Filtrated water from the Plant is redirected into the (same) open stream.

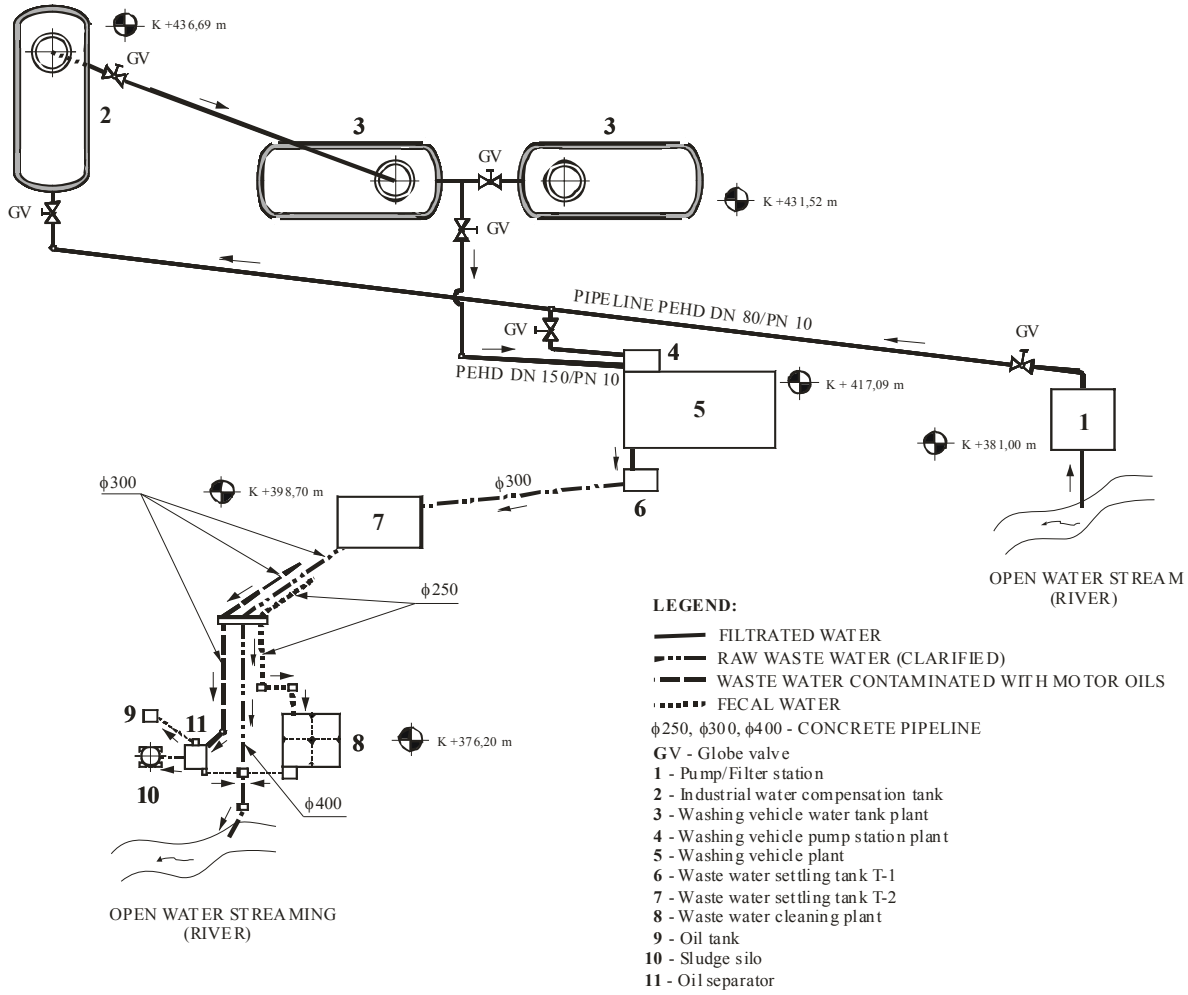

Figure 3. Layout: Optimum usage of water from an open stream

4. REFERENCES

[1] Jukić O.: Tehnički projekat tretmana voda na separaciji "Kota" u BBM – Amfibolit Vareš – Bau, Bergbau, Montage und Handel Operta – BBM GmbH, Mülheim an der Ruhr, Deutschland, BBM-Sarajevo, 2000.

[2] Jukić O.: Tehnički projekat postrojenja za automatizirano pranje teretnih vozila, RMU „Kakanj", Kakanj, 2005.

[3] Jukić O.: Tehnički projekat snabdijevanja tehnološkom vodom separacijskog postrojenja "Kota" u BBM – Amfibolit Vareš, BBM GmbH, Mülheim an der Ruhr, Deutschland, BBM-Sarajevo, 2004.

[4] Industrijski vodovod DN 80/PN 10, PK "Vrtlište"- RMU "Kakanj", Rudarski institut - Tuzla, Tuzla 2000.

[5] "Putox" postrojenje, PK "Vrtlište"- RMU "Kakanj" "Unioninvest"- Sarajevo, Sarajevo, 1985.

[6] Hodžić S.: "Transport u rudarstvu", Rudarsko - geološki fakultet u Tuzli, Tuzla, 1998.

[7] Recknagel H. & Sprenger E.: "Grijanje i klimatizacija", Građevinska knjiga, Beograd, 1984.

[8] ... , "Amiad Filtration Systems - Products Overview", Ref.92-4330-2/5.96, Israel