PIJCU, Vol. 1, No. 1, December 2023
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# Effectiveness of Pipe Installation for The Milking Process Using a Milking Machine

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***Keywords:***
Hygienic tempe,
Productiviy tempe,
3P machine,

**ABSTRACT**

*The demand for cow's milk is strong due to the size of the market, which will result in longer milking times. Fatigue is a frequent occurrence in the industrial process, particularly the milking process, when individuals still actively use their hands. Due to this, the production procedure is inefficient, and the output is likewise constrained. making a milk can, a vacuumtube, and a hose-equipped mechanized milking equipment.Creating an automatic milking machine equipped with a milk can, a vacuumtube, and a hose. The method used in this study is numerical calculation study of water flow rate and head loss inside the pipe. This is used to know more about characteristic of two configuration pipe installation. The first one is pipe configuration 7m – 1.2m – 1.2m. The second one is pipe configuration 10m – 1.2m – 1.2m. The characteristic of the pipe configuration 7m – 1.2m – 1.2m and pipe configuration 10m – 1.2m – 1.2m as follows : 1) The quantity of fluid flow vs pipe length configuration 7m – 1.2m – 1.2m is Q = 0,235 m/s^3. The quantity of fluid flow vs pipe length configuration 10m – 1.2m – 1.2m is Q = 0,235 m/s^3 also. Because the diameter of the pipe is same 2 inches. The difference lies in the length of the pipe. 2) The head loss of 7m length for laminar flow is HL = 0.530m and for turbulent flow is HL = 0.361m. The head loss of 1.2m length for laminar flow is HL = 0.091m and for turbulent flow is HL = 0.062m. 3) The head loss of 10m length for laminar flow is HL = 0.756m and for turbulent flow is HL = 0.516m. The head loss of 1.2m length for laminar flow is HL = 0.091m and for turbulent flow is HL = 0.062m*

## INTRODUCTION

The demand for cow's milk is strong due to the size of the market, which will result in longer milking times. Fatigue is a frequent occurrence in the industrial process, particularly the milking process, when individuals still actively use their hands (Aslam, et al., 2014). Due to this, the production procedure is inefficient, and the output is likewise constrained. Making a milk can, a vacuum tube, and a hose-equipped mechanized milking equipment. Examples include milking cows both manually and mechanically, noting that doing so increases the welfare of dairy cows and increases milk output by 12% while reducing labor costs by 18%. In a similar vein, (Khatri, 2021) carried out a study on the efficacy of tub-type mobile milking equipment in increasing buffalo milk output. According to the findings, for single and multiple clusters, vacuum levels of 44–46 kPa and 46–48 kPa generated the highest milk outputs (0.807 and 1.086 liters per minute, respectively). Higher milking vacuum levels can result in issues with the state of the cow's teat skin and less than ideal milk release, while lower milking vacuum levels can lengthen machine life (increasing linear slip frequency, lower milk flow rate) and can reduce milk yield (Kaskous, 2022; Enokidani et al., 2017). The teat cups (shell and silicon rubber liners), long milk tube, long pulsation tube, pulsator, vacuum pump, tank, receiver, and electric motor are the milking machine's primary features (Krawczel et al., 2017). A vacuum system, a pulsator that modifies the vacuum level around the nipple, a milking unit or group made up of four teat cups with liners attached to the claws, and a milk collection tube make up a tub type milking machine system. When the teat cup is in place, the milking machine begins to milk the dairy cow by supplying a partial vacuum to the teat. This creates a pressure difference that causes the milking duct to open and flow out of the teat (Gleeson et al., 2004).

## METHODS

The method used in this study is numerical calculation study of water flow rate and head loss inside the pipe. This is used to know more about characteristic of two configuration pipe installation. The first one is pipe configuration 7m – 1.2m – 1.2m. The second one is pipe configuration 10m – 1.2m – 1.2m.

## RESULT AND DISCUSSION

### Pipe Configuration 7m - 1.2m - 1.2m.

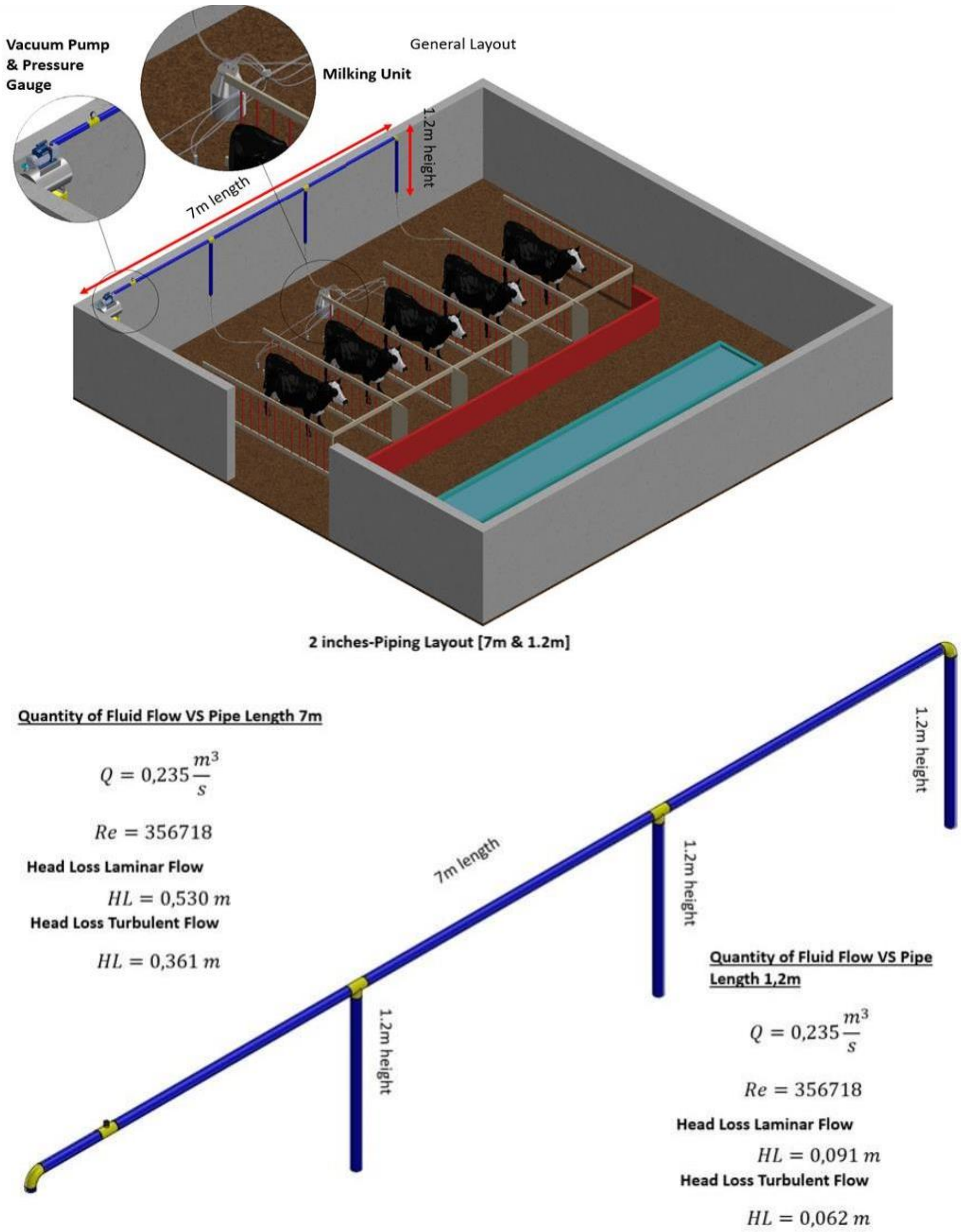


**Figure 1.** Pipe configuration 7m – 1.2m – 1.2m

**Calculation of Water Flow Rate Piping diameter 2 inches**

$Q = v \cdot A$

where :

d : Pipe inner diameter (m) == d=2 inch = 0,051m

v : Water velocity (m/s)

Q : Water flow rate ($m^3$/s)

A : cross-sectional area ($m^2$)

**Table 1.** Roughness surface value

| Surface | Absolute Roughness | |
|---|---|---|
| | $10^{-3}$ $(m)$ | *(feet)* |
| Copper, Lead, Brass, Aluminium (new) | 0.001 – 0.002 | 3.3 – 6.7 $10^{-6}$ |
| PVC and Plastic Pipes | 0.0015 – 0.007 | 0.5 – 2.33 $10^{-5}$ |
| Epoxy, Vinyl Ester and Isophthalic pipe | 0.005 | 1.7 $10^{-5}$ |
| Stainless steel | 0.015 | 5 $10^{-5}$ |
| Steel commercial pipe | 0.045 – 0.09 | 1.5 – 3 $10^{-4}$ |
| Stretches steel | 0.015 | 5 $10^{-5}$ |
| Weld steel | 0.045 | 1.5 $10^{-4}$ |
| Galvanized | 0.15 | 5 $10^{-4}$ |
| Rusted steel (corrosion) | 0.15 - 4 | 5 – 133 $10^{-4}$ |
| New cast iron | 0.25 – 0.8 | 8 – 27 $10^{-4}$ |
| Worn cast iron | 0.8 – 1.5 | 2.7 – 5 $10^{-3}$ |
| Rusty cast iron | 1.5 – 2.5 | 5 – 8.3 $10^{-3}$ |

$A = \frac{1}{4}\pi d$

$A = \frac{1}{4}\pi d = \frac{1}{4}\pi(0.051)$

$A = 0.040\ m^2$

$Q = 5.866\frac{m}{s} \times 0.04\ m^2$

$Q = 0.235\frac{m^3}{s}$

**Head Loss**

Laminar Flow

$$HL = \frac{64}{Re}\frac{L \cdot v^2}{D \cdot 2 \cdot g}$$

$$Re = \frac{v \cdot D}{\mu}$$

Turbulent Flow

$$HL = f\frac{L}{D}\frac{v^2}{2 \cdot g}$$

where :

$v$ : Water velocity (m/s)
$d$ : Pipe inner diameter (m)
μ : fluid kinematic viscosity (kg/m.s)
$HL$ : Head loss
$L$ : Pipe length (m)
$D$ : Pipe diameter (m)
f : Friction factor (0.037)
$v$ : water velocity (m/s)
$g$ : gravity [9.8 m/s$^2$]
$Re$ : Reynold number

**Head Loss Laminar Flow**

$$HL = \frac{64}{356718}\frac{7\cdot(5.866)^2}{(0.05)\cdot 2\cdot(9.8)}$$

$$= \frac{64}{356718}\frac{7\cdot(34.41)}{0.0816}$$

$$= 0.530\ m$$

$$Re = \frac{(5.866)\cdot(0.051)}{8.41\times 10^{-7}}$$

$$= 356718$$

**Head Loss Turbulent Flow**

$$HL = 0.0015\frac{7}{0.051}\frac{(5.866)^2}{2\cdot(9.8)}$$

$$= 0.0015\frac{7}{0.051}\frac{34.41}{2\cdot(9.8)}$$

$$= 0.361\ m$$

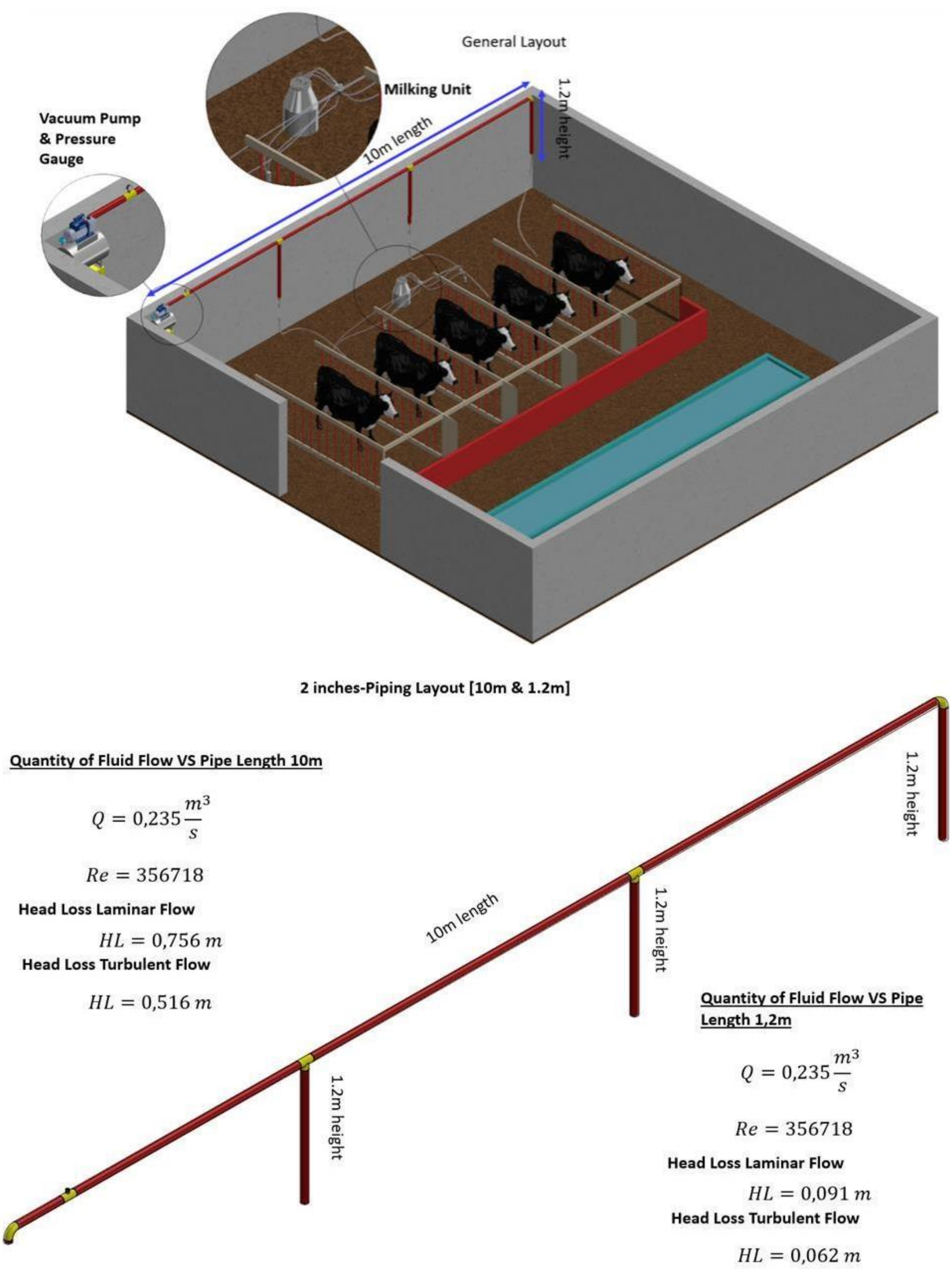


**Figure 2.** Pipe configuration 10m – 1.2m – 1.2m

### Head Loss Laminar Flow

$$HL = \frac{64}{356718}\frac{10\cdot(5.866)^2}{(0.051)\cdot 2\cdot(9.8)}$$

$$= \frac{64}{356718}\frac{10\cdot(34.41)}{0.0816}$$

$$= 0.756\ m$$

$$Re = \frac{(5.866)\cdot(0.051)}{8.41\times 10^{-7}} = 356718$$

**Head Loss Turbulent Flow**

$$HL = 0.0015 \frac{10}{0.051} \frac{(5.866)^2}{2 \cdot (9.8)}$$

$$= 0.0015 \frac{10}{0.051} \frac{34.41}{2 \cdot (9.8)}$$

$$= 0.516\ m$$

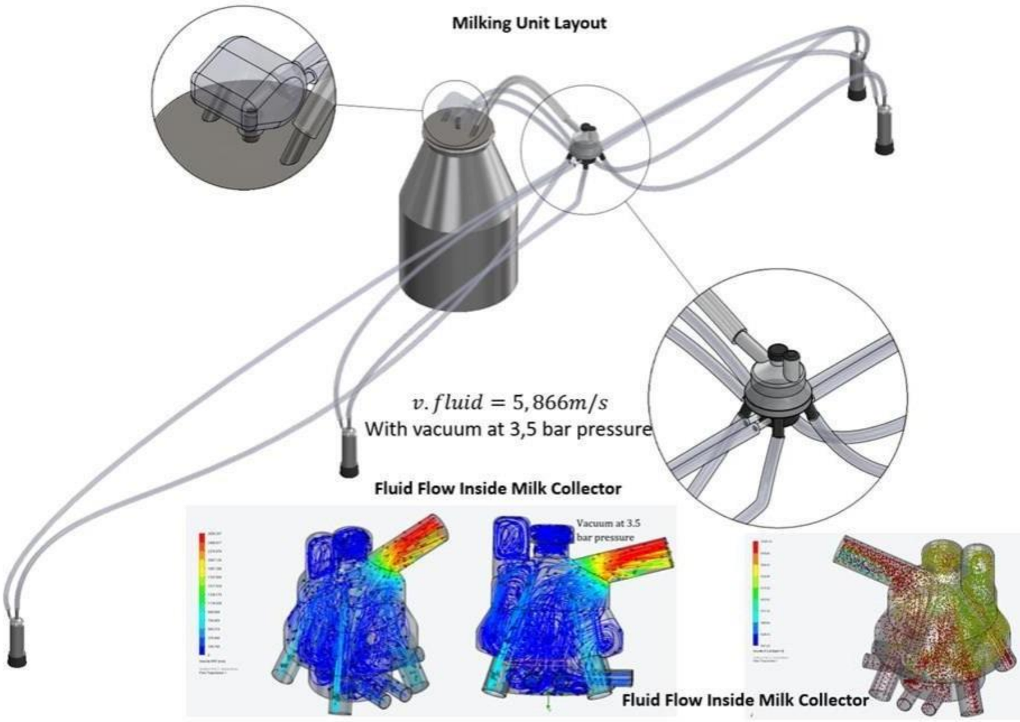


**Figure 3.** Fluid flow inside milk collector

The average milk flow rate is a good indicator of milking efficiency (Kaskous, 2022; Enokidani et al., 2017). The average milk flow rate is calculated as the total milk production divided by the total machining time (Krawczel et al., 2017). The average milking time and average milk flow rate for the entire milking group can easily be calculated.

## CONCLUSION

The characteristic of the pipe configuration 7m – 1.2m – 1.2m and pipe configuration 10m – 1.2m – 1.2m as follows: (1) The quantity of fluid flow vs pipe length configuration 7m – 1.2m – 1.2m is Q = 0,235 $m/s^3$. The quantity of fluid flow vs pipe length configuration 10m – 1.2m – 1.2m is Q = 0,235 $m/s^3$ also. Because the diameter of the pipe is same 2 inches. The difference lies in the length of the pipe; (2) The head loss of 7m length for laminar flow is HL = 0.530m and for turbulent flow is HL = 0.361m. The head loss of 1.2m length for laminar flow is HL = 0.091m and for turbulent flow is HL = 0.062m; (3) The head loss of 10m length for laminar flow is HL = 0.756m and for turbulent flow is HL = 0.516m. The head loss of 1.2m length for laminar flow is HL = 0.091m and for turbulent flow is HL = 0.062m.

## REFERENCES

Aslam, N., Abdullah, M., Fiaz, M., Bhatti, J. A., Iqbal, Z. M., Bangulzai, N., ... & Jo, I. H. (2014). Evaluation of different milking practices for optimum production performance in Sahiwal cows. Journal of animal science and technology, 56(1), 1-5. https://doi.org/10.1186/2055-0391-56-13

Khatri, S. (2021). Performance evaluation of portable milking machine on machine economy, milk yield, milking time, and milk constituents of Nepalese cattle. Agricultural Engineering International: CIGR Journal, 23(4). https://cigrjournal.org/index.php/Ejounral/article/view/6949/3733

Kaskous, S. (2022). Laboratory tests to optimize the milking machine settings with air inlet teat cups for sheep and goats. Dairy, 3(1), 29-46. https://doi.org/10.3390/dairy3010003

Enokidani, M., Kawai, K., Shinozuka, Y., & Watanabe, A. (2017). Milking performance evaluation and factors affecting milking claw vacuum levels with flow simulator. Animal Science Journal, 88(8), 1134-1140. https://doi.org/10.1111/asj.12741

Krawczel, P., Ferneborg, S., Wiking, L., Dalsgaard, T. K., Gregersen, S., Black, R., &
Ternman, E. (2017). Milking time and risk of over-milking can be decreased with early teat cup removal based on udder quarter milk flow without loss in milk yield. Journal of Dairy Science, 100(8), 6640-6647. https://doi.org/10.3168/jds.2016-12312

Gleeson, D. E., O'Callaghan, E. J., & Rath, M. V. (2004). Effect of liner design, pulsator setting, and vacuum level on bovine teat tissue changes and milking characteristics as measured by ultrasonography. Irish Veterinary Journal, 57, 1-8. https://doi.org/10.1186/2046-0481-57-5-289