VENTILATION LAYFLAT MANUAL

MLCO TRADING LTD

Reliable, Efficient, Innovative

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Preface

The invention of coated fabrics and ventilation ducts dates to back to the mid-20th century. One of the earliest applications was a lifejacket made from latex-impregnated linen cloth. This innovation laid the foundation for the development of coated technical textiles, which have since become integral to various industries.

Today, coated textiles are used in multiple applications, including:

– Roof coverings
– Wall coverings
– Technical textiles
– Ventilation systems, such as Layflat ventilation ducts

Layflat Ventilation ducts have been manufactured since the late 1940s. These ducts are produced in lengths and diameters ranging from 20 cm to 300 cm, offering diverse qualities and coupling systems to meet varying needs. Annually, hundreds of thousands of running meters are produced and distributed globally.

The success of these products can be attributed to expertise in weaving, coating, and welding processes, combined with a commitment to quality and innovation. This has resulted in reliable, high-quality products that meet the demands of customers.

We hope this information provides valuable insights into the development and use of ventilation ducts and coated fabrics, contributing to a better understanding of their applications and benefits.

Product Description

MLCO Trading's Ventilation Layflat Ducts are expertly crafted from a high-quality woven or knitted polyester textile coated on both sides with durable, softened PVC (polyvinyl chloride). The exterior coating is typically yellow, while the interior is black, providing enhanced visibility and functionality in various industrial settings.

The polyester textile core provides exceptional mechanical strength, with varying thicknesses tailored to meet the demands of different applications. Detailed specifications, including the number of threads per centimeter and the type of yarn used for warp and weft, ensure precision and reliability in every product.

Material and Construction:

- **Polyester Textile:** Engineered for superior strength and durability, supporting the duct's structural integrity.
- **PVC Coating:** Applied on both sides to ensure the duct is air and watertight, while also providing UV protection, chemical resistance, and excellent wear resistance.
- **Reinforced Construction:** Thicker coatings deliver enhanced durability and extended service life in demanding environments.

Features:

- **Seamless Welding:** The PVC coating allows individual sheets to be welded into a circular duct, ensuring a secure and airtight connection.
- **Fire-Retardant Composition:** The PVC coating includes stabilizers, fire-retardant agents, and pigments to meet safety standards.
- **UV and Chemical Resistance:** Designed to withstand environmental stressors, including exposure to sunlight and chemical reactions.

Applications:

- Temporary and permanent ventilation solutions for industrial sites.
- Air circulation and dust extraction in mining and construction.
- Climate control in agricultural settings, such as greenhouses and storage areas.

Why Choose MLCO Trading Ventilation Layflat Ducts?

Built to MLCO Trading’s stringent specifications, these ducts combine advanced material science and precision manufacturing to deliver a product that excels in durability, reliability, and versatility. Whether you require robust ventilation for demanding industrial environments or adaptable ducting for specialised applications, MLCO Trading provides the perfect solution.

Manufacturing

The textile, normally approx. 2 m wide, is coated on both sides in a coating machine in accordance with MLCO Trading 's material specification. See the material specifications for more specific details.

Typical Production Plant

A specially made machine turns and welds different lengths of the coated textile into a duct which is marked with the brand name «Ventilation Layflat», a quality designation and production data (date, month and year). The suspension system is automatically mounted on the duct as well as it being cut to the right length and finally packed for shipment.

Typical Pallet for dispatch

High-frequency welding is used, which is the most reliable method for welding PVC-coated textiles and the only welding method that produces a weld just as strong as the material.
Hot air welding should only be used for repairs, see the section entitled «Repairs».

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Material Properties

The materials used for Ventilation Layflat are made to meet the requirements posed for the operation of modern tunnels and mines.

The textile provides the requisite tensile strength to withstand the high internal pressure. Larger duct dia- meters require stronger textiles, and hence more and thicker threads.
The specially developed knitted textile gives the material a high tear resistance and thus prevents small holes and cracks from growing and causing the entire duct to tear.

The coating gives very good protection against most chemicals, water, sunlight (UV radiation) and gases. Thicker coatings provide better wear resistance.

All Ventilation Layflat qualities are self- extinguishing (tested regularly by an independent institute), which is to say that in the event of a fire the duct will burn as long as it is exposed to flames, but it will go out when the source of the fire is removed, as opposed to most other organic materials which will continue to burn.

In the event of fire, the duct will emit gas- ses such as water vapour, carbon dioxide and traces of gaseous hydrochloric acid (the latter is dependent upon temperature and the presence of other materials, for example copper). Smoke will also be released, consisting of soot and plasticiser.

Quality Control

To ensure the highest standards, all raw materials undergo extensive testing over an extended period before approval. Every batch is rigorously examined to meet strict quality benchmarks. Suppliers of yarns, coatings, and chemicals are carefully selected, with preference given to reputable international manufacturers known for their reliability and consistency.

The production process is built around robust quality assurance practices. This includes meticulous monitoring of raw material formulations, adherence to precise procedures, and detailed specifications at every stage of manufacturing. Regular audits, inspections, and testing protocols are implemented to guarantee the reliability and performance of the final products.

These stringent quality checks and standards ensure that the end products not only meet but often exceed customer expectations for durability, functionality, and safety across a range of applications. The commitment to quality is a cornerstone of ensuring long-lasting and dependable solutions.

Selection of Quality, Size and Coupling Systems

Having the best possible ventilation duct is of great importance to both workers and machines. A ventilation duct of good quality makes for more fresh air to the workplace, a lower num- ber of injuries, less extensive injuries and requires less power from the fan in comparison with a ventilation duct of poorer quality.

If the ventilation duct is of good quality, a somewhat larger fan should be selected than is necessary. This will make for a lower number of RPMs for the fan and hence significant savings as regards electricity.

In other words, for a lower total cost a better ventilation system can be obtained which requires less effort in terms of maintenance and which provides more fresh air to the workplace. In addition, you have some spare capacity which can be beneficial to have in the event that any unforeseen events occur.

What is good quality?

The strength originates from the yarn and the weave. Plastic on both sides protects the yarn and the weave against both wear and externally imposed stresses.

A good quality ventilation duct always has:

- stabilised yarn in the weave. This provides a geometrically stable duct that provides less turbulence.
- a yarn design which allows the threads the possibility to move. When subjected to loads, this provides a collection of threads that makes it more difficult to tear the textile apart.
- a plastic coating that is thick enough to protect the weave and yarn against both wear and externally imposed stresses.
- a plastic coating which is thick enough to provide good fire protection.

Basically, a knitted weave with stabilised yarn that has stronger weft threads than warp threads and a thick plastic coating provides the strongest and most optimum material for ventilation ducts.

The diameter on the ventilation duct must always be computed to be as large as possible. A duct with a large diameter provides more air than a smaller duct, alternatively it gives the same quantity of air but with significantly lower energy costs. If you do not have room for as large of a diameter as is needed in order to have good ventilation, it can pay to select two ventilation ducts with a smaller diameter. The increased purchase expenses this cause will in turn be saved a num- ber of times over in the form of lower electricity consumption.

High pressure makes for large stresses on the entire ventilation system and costs large sums in terms of energy consumption. By using ducts with a larger diameter, or alternatively multiple ventilation ducts, you can save large quantities of energy and a great deal of money.

A rule-of-thumb. If you reduce the RPMs of the fan by 20%, you will save approx. 50% in power expenses!

Selection of Supplier

The reliable injection of air through a ventilation duct of high quality is without a doubt the best investment that can be made in an underground project. Both workers and machines will be more productive when the air supply has the best possible con- ditions.

Many examples exist of projects on which savings of 2-3% have been made in purchasing prices for the ventilation system, but which have subsequently endured many produc- tion stoppages because damages had caused such large leaks that nearly no air was being transported to the workplace. Every stoppage costs many times more than the normal price differential between a good and less good ventilation duct.

The best guarantee is to purchase the ventilation duct from a serious supplier, a supplier with longstanding experience and with continuous and professional production.

A good piece of advice would be to require ISO 9001 certification. It is also good to require ISO 14001, which shows that the supplier is not just producing the product but is also interested in it being produced and used in an environmentally appropriate manner. A supplier who has these quality certifications has a good knowledge of how the product is used and can have a great deal of expertise as well as a high level of service available for both installation and operation.

General Advice and Tips

A ventilation duct is intended to be able to provide a certain quantity of fresh air to the people who work in the tunnel as well as to machines that are not powered by electricity. A proper ventilation calculation takes into account minor damage which can arise when machines hook into the ventilation duct. If the damaged areas are too numerous or too extensive, the air will leak out on its way through the duct and less air will reach the people who are working furthest inside the tunnel.

Example: How large is the leakage in a ventilation duct with a diameter of 1 m and a pressure of 3000 Pa?

Through a damaged area (tear) that is 10 cm long approx. 0.5 m^3 of air will disappear per second.

Through a damaged area (tear) that is 30 cm long approx. 5 m^3 of air will disappear per second, i.e.10 times as much.

Thus, it is extremely important that the ventilation duct be constantly maintained and that damaged areas be repaired as soon as possible.

The maintenance expenses are minimal in comparison with what the extra consumption of electricity costs. A 10% increase in the fan capacity to increase the quantity of air increases power consumption by 22%. The risk of a significant incident in which work needs to be stopped due to the lack of air also increases with the number of unrepaired damaged areas.

Installation

Flexible ventilation ducts can be connected together in many different manners. The most simple and reliable is with a steel ring on the end of the duct which is inserted into a loose end on the next duct and a coupling ring of steel which is fitted over the joint and fastened. This provides a simple and reliable connection. For larger dia- meters, it can be simpler to use two- piece coupling rings. There can also be steel rings on both ends of the duct. In this case one ring is inserted into the other and fastened with an external coupling ring.

Coupling rings are available with different profiles for one or two inner rings.

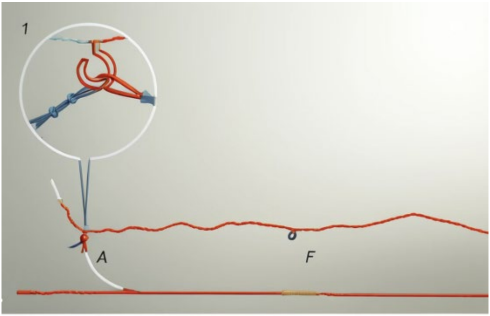
A coupling system with an inner ring and a loose duct end gives a large amount of flexibility, and different duct lengths can easily be cut in order to be adapted to the geometry of the tun- nel.

Zip couplings have been used since 1984 and can be a good alternative for long lengths of ventilation duct and large diameters. Suitable projects are long, straight TBM tunnels.

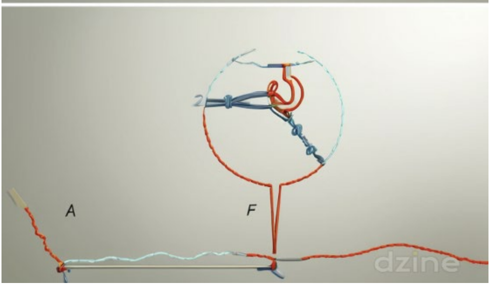
The zip coupling is permanently mounted in the end of the duct and is joined together with the end of the next duct in a simple manner.

Probably the best coupling at present is a soft coupling. It has a mechanically interlocking fabric strip that is permanently mounted on the duct. It cannot be ruined and can be used for many years.

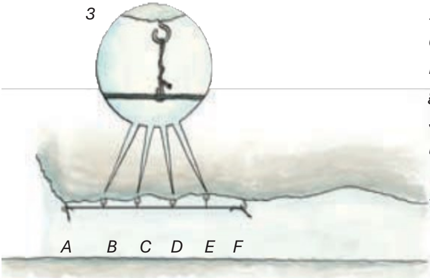
A) Cable hanging



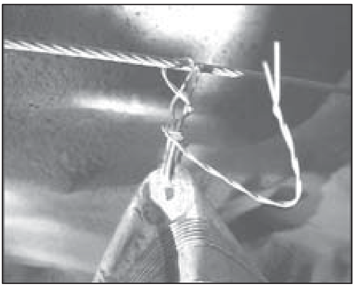
1. Fasten the cable with a cable lock to bolt A. Drill and fix bolt F in a low point on the tunnel roof approx. 25 m from A and at the same distance from the mid-line as bolt A.



2. Stretch the cable with suitable tools and fix it with a cable lock to bolt F.

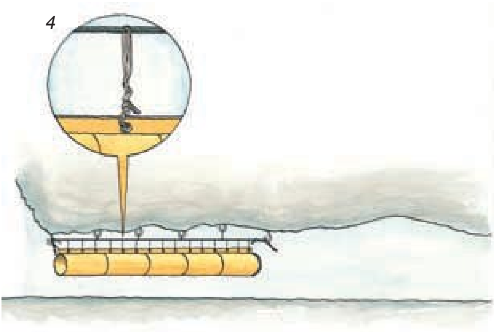


3. Drill holes for bolts B-E at distances of approx. 5 metres. Mount the cable on bolts B-E with galvanised steel wire of diameter 3 mm, with the straightest possible line between A and F.
The cable must not be drawn through the bolt eyes.

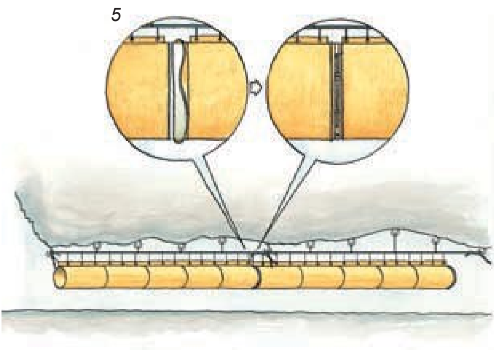


Fasten the duct with suspension wire which is adjusted such that the ventilation duct is hanging absolutely straight.

B) Installing ducts



4. Fix the duct with the suspension wire. Use the wire to adjust the distance from the cable to the duct to ensure that the latter is always hanging straight. The wire must not be lashed to the cable, but form a loop around it, allowing the duct to move freely.



5. Pull the next duct section with approx. 10 cm overlap over the welded-on steel ring at the end of the duct already in position. Fit the coupling ring over the steel ring and fasten it to the cable.

Inspection and Maintenance

When a tunnel is being bored, the length of the ventilation line will be continually increasing, and as a con- sequence of this the pressure in the ducts will increase.
Small scratches in the duct textile will also be able to crack due to the increase in pressure such that what once was a scratch becomes a hole. For this reason, periodic inspections must thus be performed of the entire length of the ventilation line, also on the upper side, for example once per week. Operational and on-site conditions determine precisely how often such inspections are necessary.

During inspections, all defects and omissions must be corrected, such as:

- all holes should be repaired
- loops and sharp bends in the ventilation line must be stretched out
- defective or damaged coupling rings must be replaced
- defective suspension wires must be replaced or repaired
- suspension wires which are hanging against a bolt should be moved past the bolt
- bolts which have come loose must be refastened
- slack suspension wires must be tightened
- check the fan, motor, gratings and other equipment

During the inspection, the airspeed and pressure in the ventilation line as well as the power consumption meter on the fan should be read and rec- orded.

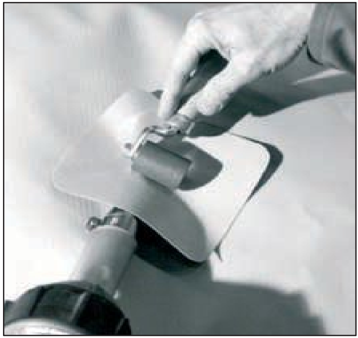
Repairs

Repairs of Ventilation Layflat using a hand-held welder

Leister Triac 1460 W hand-held hot air welder, pressure roller and spare element.

Washing of the duct textile around a tear.

Hot-air welding of a patch seen from the



Hot-air welding of a patch and use of the pressure roller.

All holes and damage to the ventilation line must be repaired as soon as possible. Holes in the duct textile are most easily repaired by welding a patch on with a Leister Triac hot-air welder while the duct is suspended and the air is flowing:

1. Cut out the damaged area if it is frayed.
2. Wash around the damaged area with VENTANON cleaning liquid.
3. If the hole is spreading, then sew it together first with narrow strips of textile or sewing thread.
4. Size the patch for the hole.
   Allow 5 cm for welding around the hole. Corners should be rounded off.
5. Spot-weld the patch to the duct textile so that it is firmly attached.
6. Weld the patch to the duct textile by running the hot air welder between the duct textile and the patch from the hole and out towards the edge of the patch and then press it afterwards
   with the pressure roller at a distance of 1 – 1.5 cm from the nozzle opening.
   Begin at the middle of the patch and weld outwards to each end. A good and properly executed patch will be just as strong as the duct textile itself. It is important that the temperature on the hot air welder is set properly and adjusted for the skill level.

During the welding, a small amount of smoke will be generated. You should avoid inhaling this for an extended period of time. Let the natural draught in the tunnel remove the smoke. Always cool off the hot air welder before turning it off.

Repairs of Ventilation Layflat with VENTLIM

Cans with Repair Patch Adhesive, pressure band and adhesive brush.

Pressure band applied.

Application of adhesive.

If the duct textile is dry, repairs with adhesive can be performed in the following manner:

1. Cut out the damaged area if it is frayed.
2. Wash the duct textile with VENTANON cleaning liquid around the hole.
3. Size the patch to the hole. Allow a minimum of 6 cm for the adhesive surface around the hole.
4. Smear VENTLIM adhesive on both the duct textile and the patch. Let the adhesive dry for a number of minutes until it ceases to be sticky. Press the patch into place over the hole. It is advantageous to go over it with a pressure roller.
5. Tighten a pressure band around the duct so that it covers the patch and then let this sit for several days.

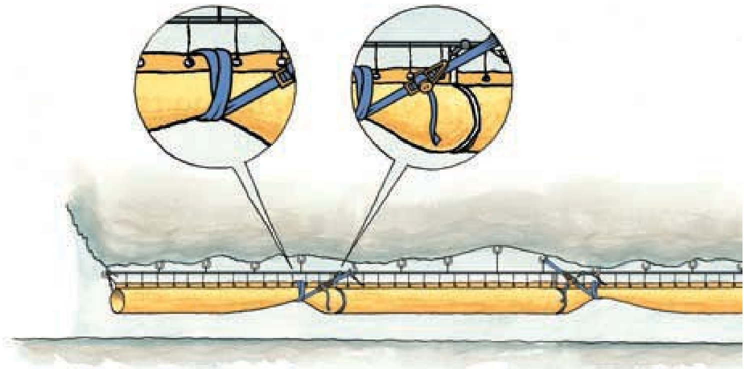
If the hole is too large or if the duct textile is thoroughly wet, then the duct should be taken down and dried. Rep- air the hole in the same manner as described above, however a load instead of a pressure band is used. Make sure that the patch does not stick to the duct textile opposite the hole.

Patching materials are available in a standard kit. For larger repairs, the duct should be sent to MLCO Trading.

The Ventilation Layflat repair kit contains Ventlim, adhesive brushes, Ventanon washing preparation, pressure band, needle, thread and ventilation duct textile.

Replacement of damaged ventilation ducts

A ventilation line which has a damaged duct in the middle and an adjacent duct on each side is reinforced with straps next to the damaged duct, with the straps being fastened to the bolt above.

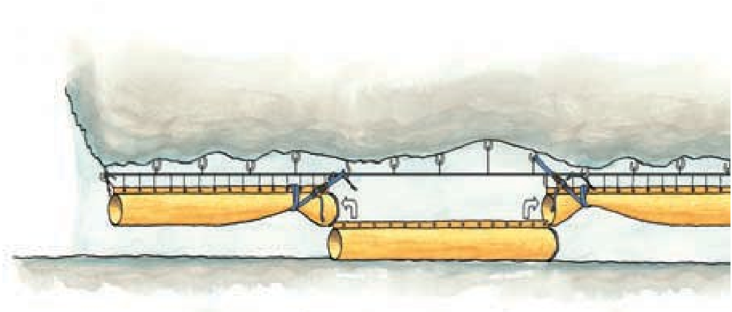


Dismounting a damaged duct.

When replacing one or more ventilat- ion ducts in a ventilation line, it is very important that adjacent parts of the line are secured before the ducts are dismounted. The following procedure is recommended:

1. Some lifting straps are required as well as a lashing belt, i.e. a lifting strap with a ratchet.
2. Approx. 5 m in on the adjoining duct, fasten a lifting strap around the duct.
3. With the ratchet between them, fasten the opposite end of the belt to a bolt above the duct that is to be replaced.
4. The adjoining duct is then ratcheted towards the duct(s) that are to be replaced such that there clearly is slack in the ventilation line.

5. Open the couplings and take down the ducts concerned.
6. Suspend new the duct(s) and tighten as best as possible before coupling.
7. Detach the lashing belt and lifting straps, and remove them.
8. After approx. one week, inspect the ventilation line. If there is any slack or kinks in the line, then they must be tightened up.



Insertion of new duct.

De-installation

Prior to de-installation (while everything is still hanging up) the ducts in the ventilation line should be sorted and marked such that they can be packed into the following three separate classes:

Class 1:	Ducts which are free of defects and have no damage.
Class 2:	Ducts which have damage/ holes and need to be repaired
Class 3:	Ducts which are in such bad condition that it cannot be regarded as profi- table to repair them, i.e. scrap.

The content of all pallets must be clearly marked, i.e. quality, dimension, number of ducts (running metres) and class.

Suspension hooks should be new for each installation of the ducts. Hence when de-installing, the suspension hooks should be cut with wire cutters so that they are not sitting in the eyes.

Due to considerations for the working environment, all ventilation ducts should be cleaned when they are reused. This is most easily done while the ducts are hanging up and right after de-installation. Vehicles and/or equipment which are used in the de- installation should also be cleaned. Take the ducts down one at a time and pack them up, sort them by class and place them on pallets which are tied down. Since the duct textile does not rot, it is not necessary to dry the ducts before storing them. If it is not possible to perform cleaning while the ducts are suspended, then they must be cleaned prior to packing.

Prior to reuse, ducts with damage should be repaired, and in such case preferably at MLCO Trading. Used ducts should preferably be used at the end of a ventilation line.

Storage

Ventilation ducts should always by sto- red on pallets which are securely tied down and marked (see the section on de-installation). Ventilation Layflat can be sto- red outdoors, however it is beneficial for the ducts to be screened from strong sunlight and extreme heat, either by covering the ducts or, even better, by storing them indoors.

Several pallets with used ventilation ducts that have been properly packed and tied down with tension straps.

Computation of Air Requirements

It is extremely important for the people who work underground to have fresh air to breathe. If the air is full of diesel gas, blasting gas or dust, there is a large risk that life-threatening accidents can arise.

Ventilation computations for underground work are normally performed using a computer program. This is based upon SIA 196. It is however quite simple for anyone who wishes to acquire a sense for the magnitude of the amount of air required to perform a simple computation on their own. In order to efficiently dilute dangerous gases and dust, a return speed for air in the tunnel of between 0.3 and 0.6 m/s is normally required (if a risk exists of the presence of methane gas, then 1 m/s should be used).

The objective is to determine how much air in m^3/s is needed at the bot- tom of the tunnel in order for the return velocity to be sufficient and in order to be able to dilute gases so that it is possible to breathe the air without it posing a health hazard.

In order to clear diesel gas out, a minimum of 4 m^3 of air/kW/min. is required at the bottom of the tunnel (6 m^3/kW/ min. for a motor without a particle fil- ter). An estimate is made of how many kW are being used simultaneously in the tunnel and then the computation is made to determine the total amount in m^3 of air/second.

Each person who is in the tunnel needs 3 - 5 m^3 of air/minute and a comp- utation is made to determine how many people are normally in the tunnel at the same time, then the total amount is worked out in m^3/minute. The two results obtained are then added together and approx. 10% is added for blasting gas. The end result is what at a minimum is needed in terms of air at the bottom of the tun- nel in m^3/minute.

In order to compute how many m^3/second have to come out of the fan, the leakage in the ventilation ducts have to be computed.

A well-mounted ventilation line of good quality has a leakage of less than 1%/ 100 metres. If the ventilation line is poor, a higher amount of leakage must be reckoned with. This value is added to the quantity of m^3/minute that has been computed for the bottom of the tunnel.

The minimum value arrived at in m^3/ minute should then be increased by a margin of safety.

Once you know how much air is needed in terms of m³/second, then you go to the Ventilation Layflat Nomogram where you can read off the pressure in the duct for different diameters as well as the power that is required from the fan.

Correct computational formulas look like the following:

a) *Computational formulas: Static pressure in the duct:*

$$\square p = \square\square\square x/D \square\square/2 \square U_X^2$$

□x	=	*length (m)*
□p	=	*pressure loss over □x*
□	=	*average coefficient of friction*
D	=	*diameter of the duct (m)*
□	=	*specific gravity of 1 m³ of air (kg)*
U_X	=	*average velocity in the length concerned (m)*

b) *Dynamic pressure in the duct:*

$$\square p = \square/2 \square U^2$$

c) *Pressure loss at intake, bends, outlets and also changes of diameter, etc. For each, we have to calculate:*

$$\square p = \square\square\square/2 \square U^2$$

□	=	*Zeta coefficient for singular loss*

d) *In order to arrive at the total pressure (pt) required, we must add: pt = □p + □p*

dynamic + $\square p_2$ *+* $\square p_2$ *.....*

e) *Computation of energy consumption for the fan is based upon the following formula: N = (Q □ Pfan)/(□v □*

□m)[kW]

Q	=	*airflow from the fan (m³/s)*
Pfan	=	*total pressure from the fan (Pa)*
□v	=	*efficiency of the fan (0,4 □ 0,85)*
□m	=	*efficiency of the motor (approx. 0,95)*

In order to avoid electricity costs which are too high, the ventilation line must have as large a diameter as possible. A large diameter makes it easier for the air to flow and requires less power from the fan.

If the pressure in the ventilation line is too high (requires a lot of power from the fan), the diameter must be increased. If this is not possible due to insufficient room, then two ventilation lines should be mounted instead of one. The same quantity of air in two ducts instead of one duct requires 1/2 the quantity of air, 1/4 of the pressure and 1/8 of the energy consumption (the power from the fan).

It is always economically sound to invest in high quality for the ventilation line and to treat it well. A good, properly installed and non-leaking ventilation line provides not only a good working environment for the employees, but it also provides such large energy savings that a 20 - 40 % difference in the price of the ventilation line is insignificant.

List of references

Mopani Copper Mines PLC

NFC Africa Mining

Lubambe Copper Mines

Kamoa Copper SARL

Kamoto Copper Company SARL

Kinsenda Copper Company SARL

Reliant Mining & Construction Ltd

Opermin Zambia Ltd

Kansanshi Mining Plc

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