Mine Air Systems- Mining HVAC

Headquartered in Milwaukee, Wisconsin, Komatsu Mining Corp. is part of the global Komatsu family of companies; indispensable partners to the mining, forestry, industrial and construction industries. Komatsu Mining provides essential equipment, systems and solutions used by companies worldwide to extract fundamental minerals for developing modern infrastructure, technology and consumer products. Komatsu Mining Corp. is home to the industry-leading P&H, Joy and Montabert equipment and service brands for mining and related industries. The company’s history in Milwaukee dates back to the origin of the P&H brand in 1884.

Globally, Komatsu has more than 57,000 employees in 142 countries. In the United States we employ nearly 8,000 directly and nearly 10,000 indirectly through distribution. With service centers and manufacturing facilities across the globe, we aim to be near areas of major mining activity to support our customers directly and collaborate regularly. Komatsu was founded in Japan in 1921, but our brand histories date back even further, to 1884 in Milwaukee, WI, USA, where the P&H mining brand was founded and is still headquartered today. Our leading Joy brand of underground and hard rock mining solutions was founded in 1919 in Indiana and is now headquartered in Warrendale, PA, USA.

February 2019
Paul Krug
MAS Product Manager
Company Overview

1884 Alonzo Pawling & Henry Harnischfeger found Pawling & Harnischfeger Machine & Pattern Shop in Milwaukee.
1895 When recession cools the demand for overhead cranes, the company begins to develop a product line that includes earth-moving machines.
1910 Develops a line of earth-moving machines for construction and mining operations.
1914 Becomes Harnischfeger Corporation.
1920 Launches the Model 206 Excavator - the first in a long line of best-selling shovels for mining.
1930 Is one of the first manufacturers to apply all-welded design and fabrication to its equipment.
1934 Harnischfeger Fund is started with $50,000 from the estate of Henry Harnischfeger to support civic and cultural groups in Milwaukee.
1942 Ramps up production of shovels, cranes, and hoists to support the World War II war effort.
1954 Rolls out the Model 1800 electrical mining shovel; mines refer to this model as the "Pride of the Pit".
1968 Launches the 2800 Mark I class shovel, featuring a new Electrotorque drive system, designed to meet the world's growing demand for coal, iron, and copper.
1988 Acquires the Page Engineering walking dragline product line.
1991 Launches the 4100C electric mining shovel. Also acquires the Gardner-Denver line of production drilling rigs.
1996 Launches the 9020 walking dragline in Australia and the 120A blasthole drill, which becomes the preferred blasthole production rig for iron mining. Also launches a global network of regional service centers.
2001 Launches the 4100C BOSS shovel specifically for the growing oil sands industry.
2004 Releases Centurion, a supervisory and data acquisition system for shovels.
2006 Launches the 320XPC Centurion-class, heavy-duty drilling rig.
2010 Launches PreVail machine health monitoring system.

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Mine Air Historical Information

Started as Procon Calgary in 1993 from providing a solution to a single TECK mine site in Sparwood BC.
Acquired by JGI Canada in 2000.
Moved to JGI Longview TX 2016.
Now ~ 3000 Units supplied (world wide) incl Canada, U.S.A., Africa, South America, Australia, and more.
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55325 – Sierrita conversion @ FCM – Arizona (copper)

Conoma Coal – Hitachi 5500 Update/conversion
British Columbia – Met Coal

Some Examples of Mining AC

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24 volt DC electric condensing unit for use on diesel driven equipment
What we do is design standard modular systems then apply them to more specific machines using the concept of kits to adapt. We have 3 phase systems in 1000 and 1500 cfm sizes (or ~ 3 ton & 4 ton capacity). We have 24 vdc systems in 350 and 500 cfm sizes (or ~ 1 and 1.5 ton capacity).

- Reliability - Ease of service – speed of service is a prime decision maker. Less interested in cost and efficiency.
- Must deal with outside air – about 125 cfm for a single operator cab

MAS Kits: Applying standard MAS modules and units to a variety of equipment using building blocks for standardization

4100A side mount kit “KIT-177”

930E older cab “F2 MRC5 kit”
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The Mining HVAC market is global

Komatsu Can
Teck Coal
Komatsu USA
Bingham County Mine (Trucks-120+)

Komatsu USA
US Steel MN (drill)
Where the lows are -40°F

Komatsu Australia
Mauritania – SNIM iron Various Diesel Machines
Even Hotter!

Komatsu Columbia & Panama
Where the humidity never stops

Komatsu Africa
Various Diesel Machines

World Map
Mine Air Systems- Mining HVAC

ISO 10263-3:2009 specifies a test method which will provide for uniform measurement of the maximum pressurization inside an operator enclosure of an earth-moving machine when equipped with a pressurization system.

We understand that silica dust is unacceptable for operators – but for the air conditioning designers, the thought of an uncontrolled amount of unconditioned air flowing into the cab leaves us at odds with understanding the correct capacity to target.

A typical system will take in 25 to 75 cfm and provide a minimum of .20” of WC pressure.

So what happens when the door seals are worn, torn or missing, and when various trades drill holes for wires and hoses? The A/C gets blamed for not keeping up!
Takeaways – what can we do?

1. Step one is to verify that the factory installed air filtration system is in good operating order.

2. Look at the filters. Evaluate them. Any OE factory filter may or may not be suitable for the specific application at hand. Dust types and particle sizes vary widely. Generally HEPA filters plug up extremely quickly and heavy construction or mining applications. The correct filter for the job should be used.

3. Make sure that the filters seal adequately to the filter rack. This is an area that often causes concerning leak by.

4. Confirm that the cab has an operating pressurizer, and that the cab is sealed well enough to be pressurized at the minimum 0.2 inches of water column. Older cabs can be quite leaky! And sealing them can be a big job. But if this is not done, fixing filters & HVAC systems can be pointless.
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Takeaways – what can we do?

5. Good maintenance is your replaceable. Does the owner of the equipment stock adequate filters, and are they checked and replaced regularly? Any manufacturers recommended filter replacement cycle time is simply a guide, local conditions very dramatically.

6. Is there any kind of dirty filter reminder? Is there any kind of pressure indicator to let the operator know that his system is operating well? I have seen some very nice instrumentation on this installed in Australia.

7. Is the air-conditioning system operating correctly? An operator that does not have sufficient cooling provided may be tempted to leave the door open, or if it’s an older machine, open a window. They are then possibly exposed to high and harmful dust levels.

8. Good to cab housekeeping cannot be overlooked. A filthy cab is going to do nothing but recirculate dust that has been tracked in from outside. The filter can help with that. Sometimes they mindset of the fleet owner overlooks details like that. However, when it’s pointed out that unhealthy conditions can exist, sometimes the air-conditioning technician can make progress there.
In building and mechanical trades, we have a great deal of design guideline material out there from AHRI, ARI, and others. This is great information that we all need to know. However, in mining, we have other challenges to consider. Some very deep challenges. We install worldwide (so design condition may be very off standard), we are frequently subjected to crazy shock and vibration loading, power is by definition power quality, and the simply filthy atmosphere is nearly untenable. Combine this with the millions of dollars that the host machine is valued at, and reliability is expected to be very high.

This is a different sort of design criteria!

2.1.1 SAE PUBLICATIONS

SAE J1012—Operator Station Pressurization System Test Procedure
SAE J1091—Earthmoving Machinery—Operators Field of View
SAE J1116—Categories of Off-Road Self-Propelled Work Machines
SAE J1163—Determining Seat Index Point
SAE J1349—Engine Power Test Code
SAE J1533—Operator Enclosure Air Filter Element Test Procedure

SAE J1559—Measurement of Solar Heating Effect
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2.1.2 ISO PUBLICATIONS
ISO 5006-1—Earth-moving machinery—Operator’s field of view
ISO 5353—Earth-moving machinery, and tractors and machinery for agriculture and forestry—Seat index point
ISO 5721—Tractors for agriculture—Operator’s field of vision
ISO 9249—Earth-moving machinery—Engine test code—Net power

2.2 Related Publications
The following publications are provided for information purposes only
2.2.1 ASHRAE PUBLICATIONS
ASHRAE Temperature Measurement 4166
ASHRAE Handbook of Fundamentals, 1981
2.2.2 ASME PUBLICATIONS
ASME Power Test Code, Pressure Measurement, PTC 19.21972
ASME Power Test Code, Electrical Measurement, PTC 19.61955
2.2.3 ISO PUBLICATIONS
ISO 10263-4—Earth moving machinery—Operator enclosure environment—Part 4: Operator enclosure ventilating, heating and/or air-conditioning test method
ISO 14269-2—Tractors and self propelled machines for agriculture and forestry—Operator enclosure environment.
Cost Considerations - Mining HVAC

So if we are all in the business of making money – how does that factor in? If it’s all about cost, in much of mobile air conditioning the cost can be measured on a purchase order. In mining and heavy construction, there are more pieces to consider.

- Reliability – how long between breakdowns – MTBF
- Uptime – When it breaks – how fast can I get the host machine back in service?
- Total cost of ownership – including maintenance and parts
- How common are the parts & how quick can we get them?
- Can I avoid union disputes or MSHA type fines with the right systems?
- Can I lower worker risk with a proper system?

Do we think in these terms as manufacturers and system designers, or do we try to get a system designed and installed at the lowest price?

Do we understand what our customers are really asking for?
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Questions Raised - Mining HVAC

Ok –

If we do all of these things but one mfg makes evaporator system, another makes condenser side, a third makes the control, and a fourth makes the pressurizer – how do we ever as an industry pull these things together and develop systems that meet these cost, performance, safety, and reliability requirements? We have these disparate SAE, ISO, ASME, and ASHRAE documents but few have an understanding of how to apply them, test them, qualify and quantify them.

We sell based on BTUH – rarely using transparent ratings or std conditions
We advertise CFM – but usually with little understanding of ΔP
We brag about reliability – but have little data to back it up
Can we do better as an industry?
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Design Related

SAE J1503

FIGURE 1—TEMPERATURE AND VELOCITY LOCATIONS (DIMENSIONS IN mm)
Remember this slide?

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Design - Testing
4. Test Equipment and Instrumentation

4.1 A test enclosure sufficiently large to contain the base machine with provisions to circulate conditioned air and to load the machine’s engine and transmission if required.

4.1.1 Field test conditions may be used.

4.1.2 If it is not practical to test the base machine due to physical size limitations, the operator enclosure may be bench tested with the loads imposed by the base machine on the enclosure simulated. When bench testing is conducted in conjunction with solar loading, shading of the cab similar to that which is encountered on the vehicle in field conditions is permitted. If this procedure is used, correlation with field data shall be established.
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Our test lab may be in a building – or on a live machine far too big for any lab.

Design - Testing

Strain Gauge setup for	Komatsu Arizona Proving Grounds
Assessing sheet metal integrity (Sahuara, AZ)

Real-time measurements
No where in here did we answer all your questions about mining and heavy air conditioning – but I trust if nothing else, you understand why it’s different, why the requirements are so different, and why I believe we could all work together much better to improve the product offerings here.

Thank You