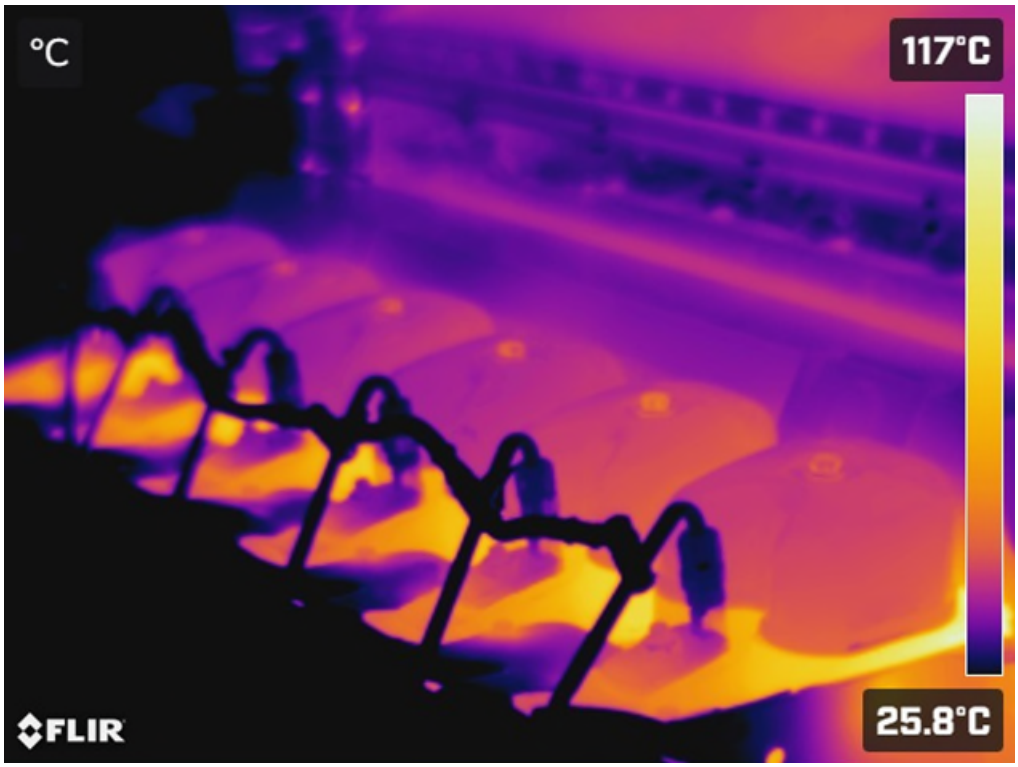
Costs saving in maintenance by expanding the use of thermographic imaging.



In short:

Degrading components transfer energy in one way or another, e.g. pressure differential, electrical, mechanical etc. All these items lose a part of that energy to heat. In general, the further the degradation of the component the bigger the temperature increase, which in return leads to faster degradation. Thus, degradation increases exponentially near End-Of-Life. (E.g. A hot breaker increases in resistance, a loose v-belt generates more friction, etc.)

Most companies are familiar with the thermal camera to periodically inspect electrical components. However, this is very limited due to it being a periodical inspection and only focusing on electrical components.

1. More can be achieved by including mechanical and operational items in the inspection. Think for example of: Breakers, belts, bearings, turbines, heat-exchangers, motors etc.
2. Even more can be achieved by setting up an administration where every critical item is listed per platform and systematically checked using the thermal camera. This would allow for trending over time and catching the minuscule temperature increases that indicate future breakdown. Allowing for more planned maintenance.

Such a condition monitoring program would be relatively low cost to perform; After the initial investment of setting up the administration and creating the routes it becomes a low effort matter of systematically collecting data at fixed intervals allowing for trending over time.

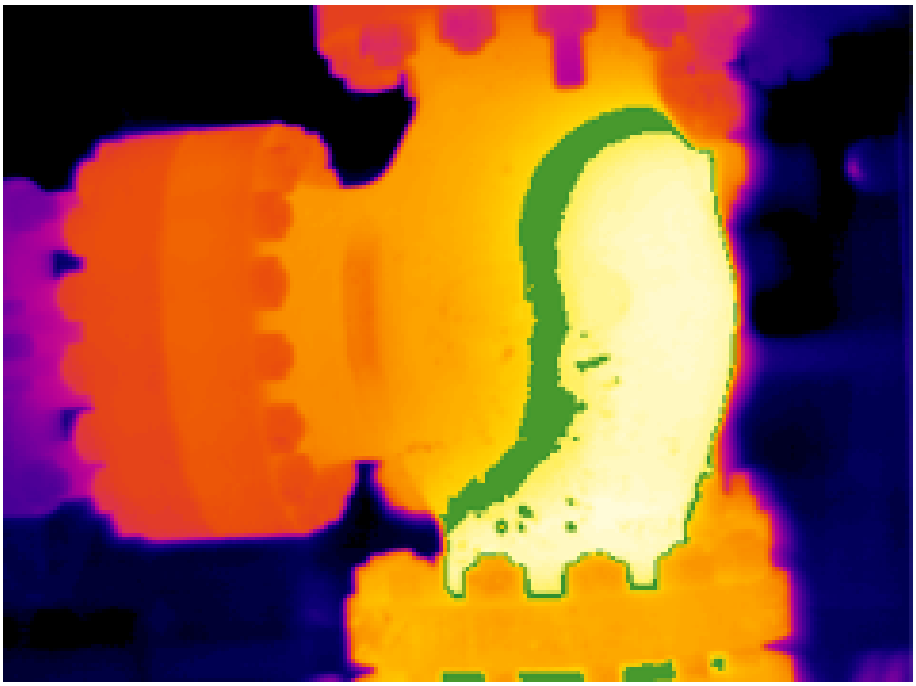
CondIR

In not so short:

1. Expanding to mechanical & operational components:

A thermal imager, in the right hands, is capable of much more than acting like a glorified thermometer. With adequate understanding of blackbody radiation and the thermal properties of different materials (emissivity/transparency/reflectivity) we can look to 3-hundreds of a degree K temperature differences. The fact that it is an imager also allows us to analyze the thermal pattern (How heat distributes through the material). All this allows for fast, reliable and non-destructive research.

Performing periodical inspections on mechanical items such as belts, bearings, motors, pumps and valves has the potential to significantly reduce unplanned downtime by finding components in the process of failing, allowing for scheduled maintenance to be performed.



- Inspecting a valve's internals by analyzing the thermal profile

The thermal camera provides an excellent tool for fault finding and diagnostics. For example, and in no way limited to; Finding blockages in pipelines, performing engine diagnosis, check for axel misalignments etc.

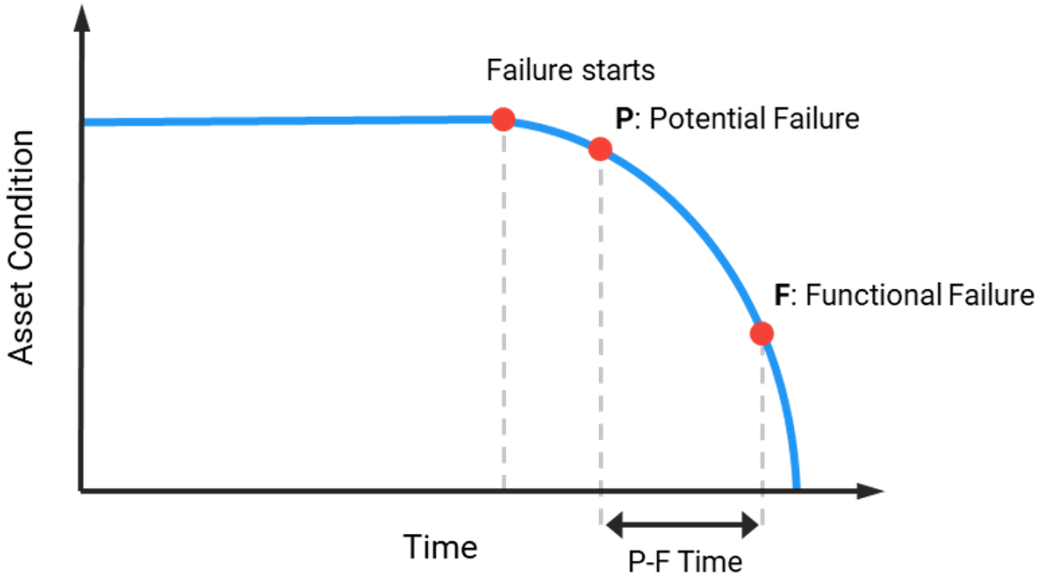
The camera can also be used for operations. For example, to verify valve positions, check internals of pipelines/valves, find corrosion under insulation, refractory problems, measure sediment in tanks or verify liquid levels.

You'll find examples of mechanical cases in appendix B.

You'll find examples of operational cases in appendix C.

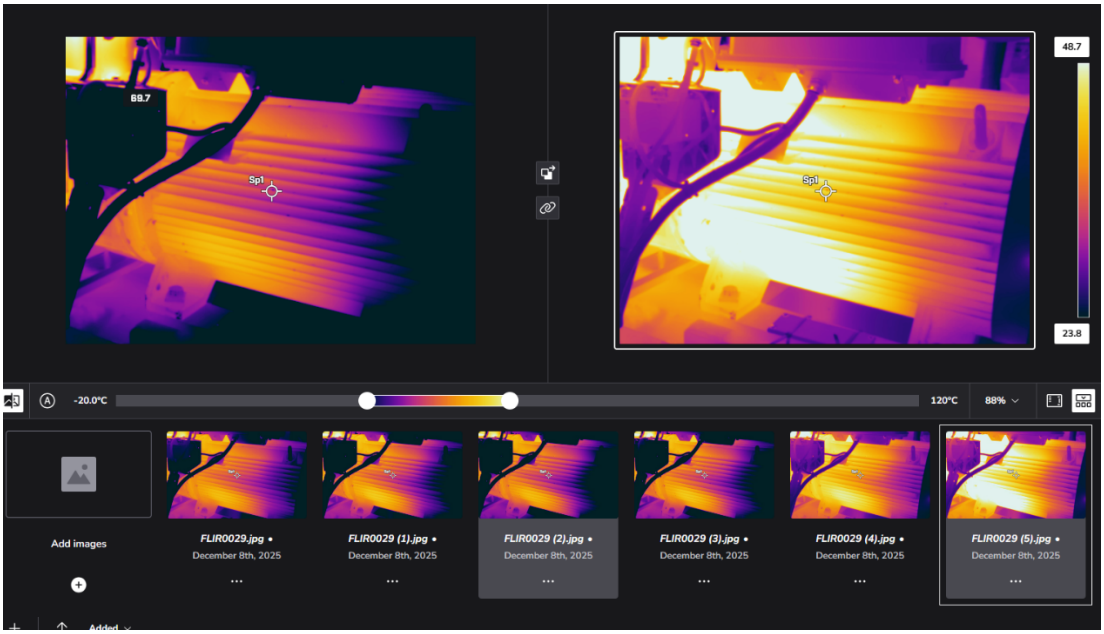
2. Expanding to condition monitoring

As mentioned in the intro, there is an exponentiality to the temperature increase of degrading components. The goal of condition monitoring would be to “catch” an item at the start of degradation, allowing enough time for maintenance to be planned accordingly instead of reacting to breakdown.



- The key goal here is to find the fault in the beginning of the curve, before it leads to significant failure.

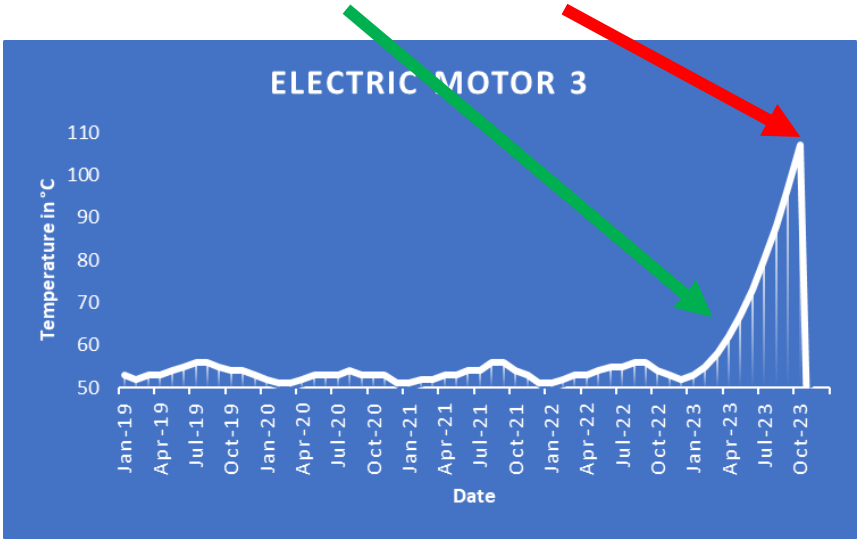
By setting up an administration of all items whose condition we want to monitor, followed by taking baseline-images of different types of components to assess the correct working temperatures and then taking measurements at regular intervals. We will be able to start trending the miniscule temperature differences



- Motor temperature makes a steep increase in the last 2 measurements, indicating a fault.

By plotting measurements over time, we can see the signals of degradation months before the component fails. Allowing for corrective maintenance to be planned, thus playing a major part in the costs saving program.

Act here. Not react there.



- Switching to predictive maintenance.

CondIR

3. Appendix A: Costs prevented calculation

The following is a real-life example of downtime that was prevented on a offshore location. This item was at the end of the curve and on the point of failure. We were able to replace the item and prevent unwanted downtime.

Keep in mind that this was discovered following a 3y maintenance plan and therefor a “lucky catch”.

Cost Avoidance Calculation

In 2025 the stabilizer card of PE-911 is found to be faulty using thermographics
This spreadsheet is designed to answer the question: **What might happen if this component had never been inspected?**
Once an anomaly is found, one of three things will happen:

1. The component fails during bibby season and is repaired during regularly scheduled hours. — BEST CASE
2. The component continues to get worse, scheduled flight is needed for repair. — MEDIUM CASE
3. The component fails in winter, FIM team must fly unscheduled to repair. — WORST CASE

Stabilizer card on the PE-911 has failed, resulting in shutdown of the engine and subsequent platform SD.

Best case:	**Bibby is in the fiel and component is spare onboard. Platform is not producing for planned maintenance anyway**
Medium case:	**Statistically in between best and worst case scenario's**
Worst case:	**Component fails in winter during high production. FIM team has to fly, diagnose and resolve**

Category	Best case	Medium case	Worst case
testing/diagnosis (hours)	0	0	0
planning/management (ho	0	0	0
man hours	12	24	48
overtime (hours x 1.5)	0	0	0
Misc hours	0	0	0
Total Labor hours	**12**	**24**	**48**
Total Labor Costs	€ 1.020,00	€ 2.040,00	€ 4.080,00
Costs helicopter	-	€ 9.000,00	€ 15.000,00
Parts: stabilizer card	€ 100,00	€ 100,00	€ 100,00
Parts	**€ -**	€ -	€ -
Parts	**€ -**	€ -	€ -
Parts - total	**€ 100,00**	€ 100,00	€ 100,00
Production Hours lost	**0**	12	36
Lost Production Cost	-	€ 54.000,00	€ 162.000,00
Business Interruption			
Miscellaneous			
Total Costs	€ 1.120,00	€ 65.140,00	€ 181.180,00
Probability	70,0%	40,0%	10,0%

Testing/diagnosis cost per	€	-
Management cost per hour	€	-
Labor cost per hour		€ 85,00
Production cost per hour		€ 4.500,00

Assuming 75% of K1A's maximum potential at €0,32 per m3

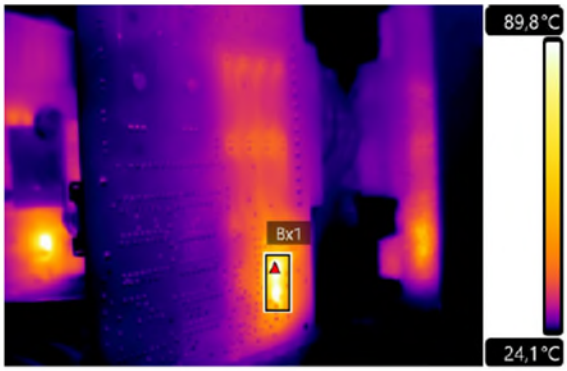
	CASE AVOIDED COSTS
Best Case	€ 784,00
Medium Case	€ 26.056,00
Worst Case	€ 18.118,00

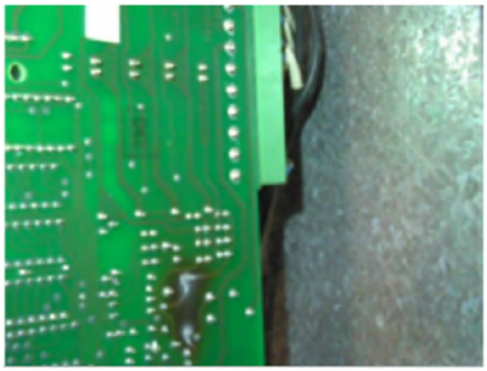
TOTAL AVOIDED COST	**€ 44.958,00**
ACTUAL COST OF REPAIR	€ 0,00
NET AVOIDED COSTS	**€ 44.958,00**

- Excerpt from the report regarding this calculation.

TotalEnergies

FLIR0262.jpg | 289° W 27/04/2025 | 14:24





Spots	-
Lines	-
Bx1 Average	69,8 °C
Bx1 Maximum	116,3 °C
Bx1 Minimum	37,8 °C
Bx1 Area	0,0 m²
Ellipses	-
Deltas	-

Parameters	
Emissivity	0,95
Reflected temperature	20,0 °C
Distance	2,0 m
Atmospheric temperature	15,0 °C
Relative humidity	60%
External optics temperature	20,0 °C
External optics transmission	1,00

Image Compass Data	289° W

Text annotation	
Text Annotations	PE-911: A201

Note

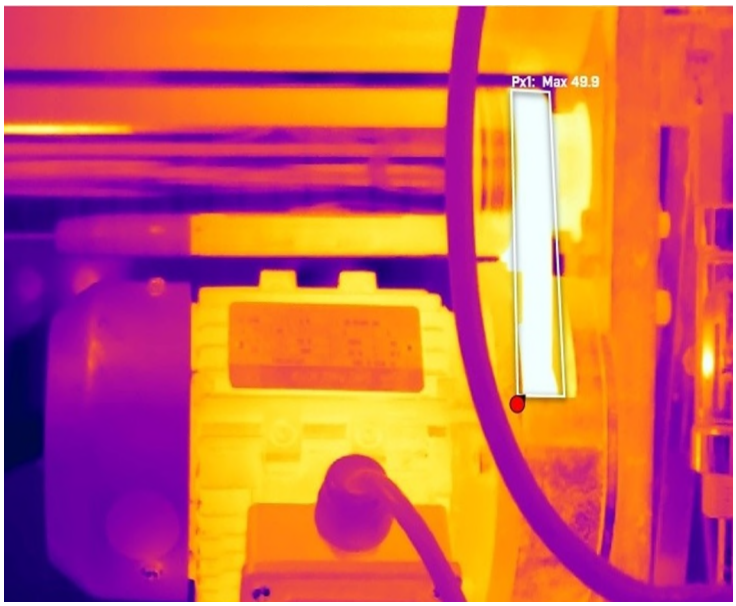
Resolved

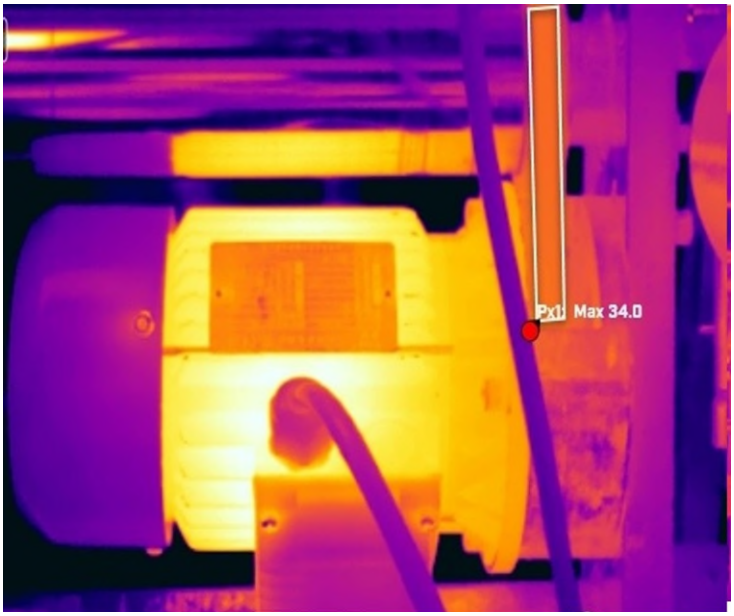
Component on stabilizer card “A201” was found to be overheating, already showing black marking and signs of decay. Similar card was found in stock at the warehouse and flown in with the first helicopter. FU notif 1100186258 was made and card has been replaced.

Subsequent thermal inspection shows the new card is performing within limits.

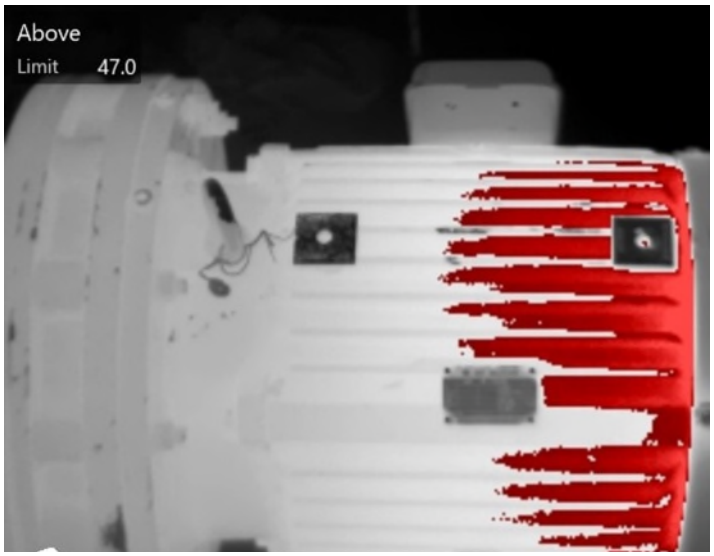
4. Appendix B: Mechanical examples

- Belt wear causes slippage. (Left)
- Belt in normal operation. (Right)

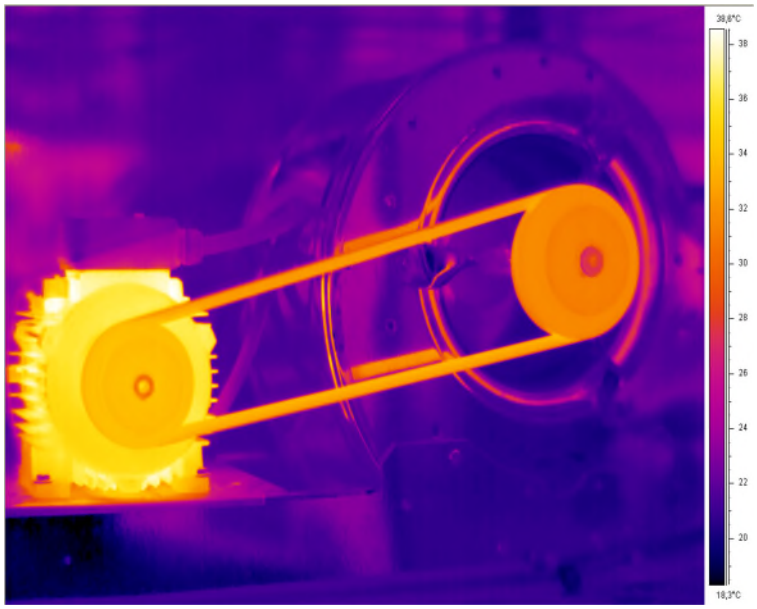


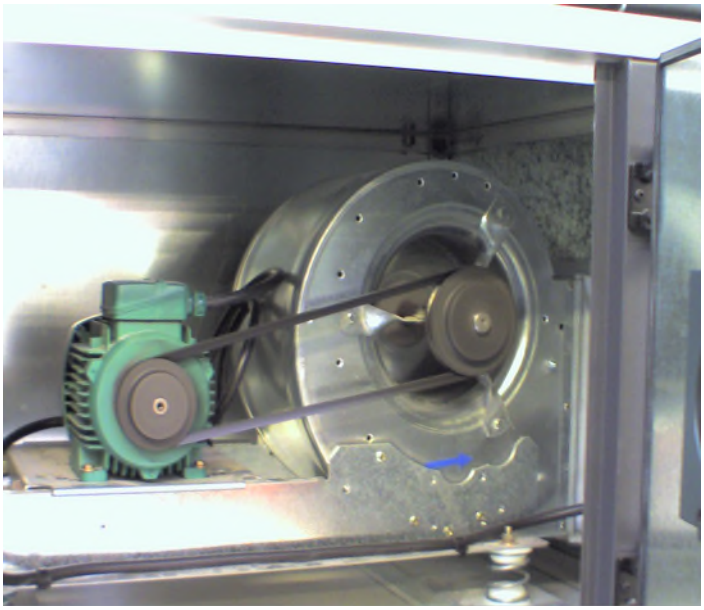


- Brake gap set incorrectly, causing excess drag on motor.
- Visible only by analyzing the thermal profile.

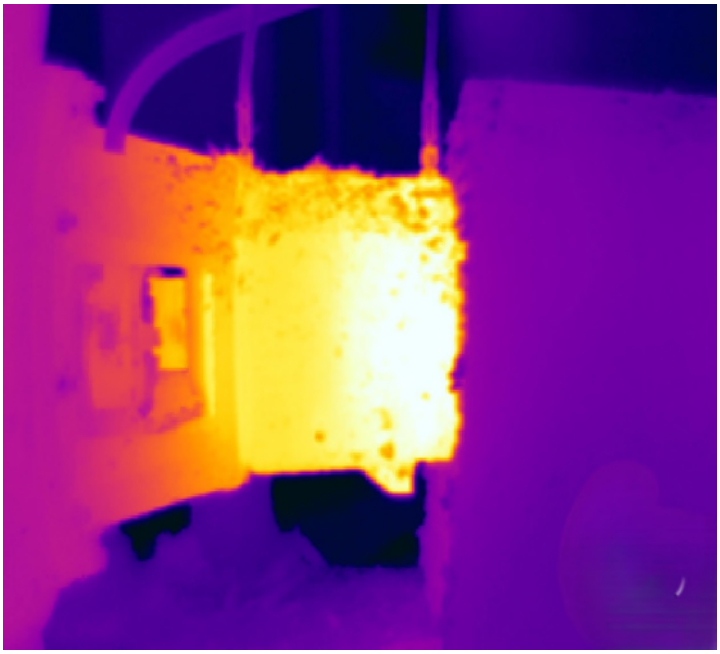


- Defective motor, causing belt and drive to heat up.

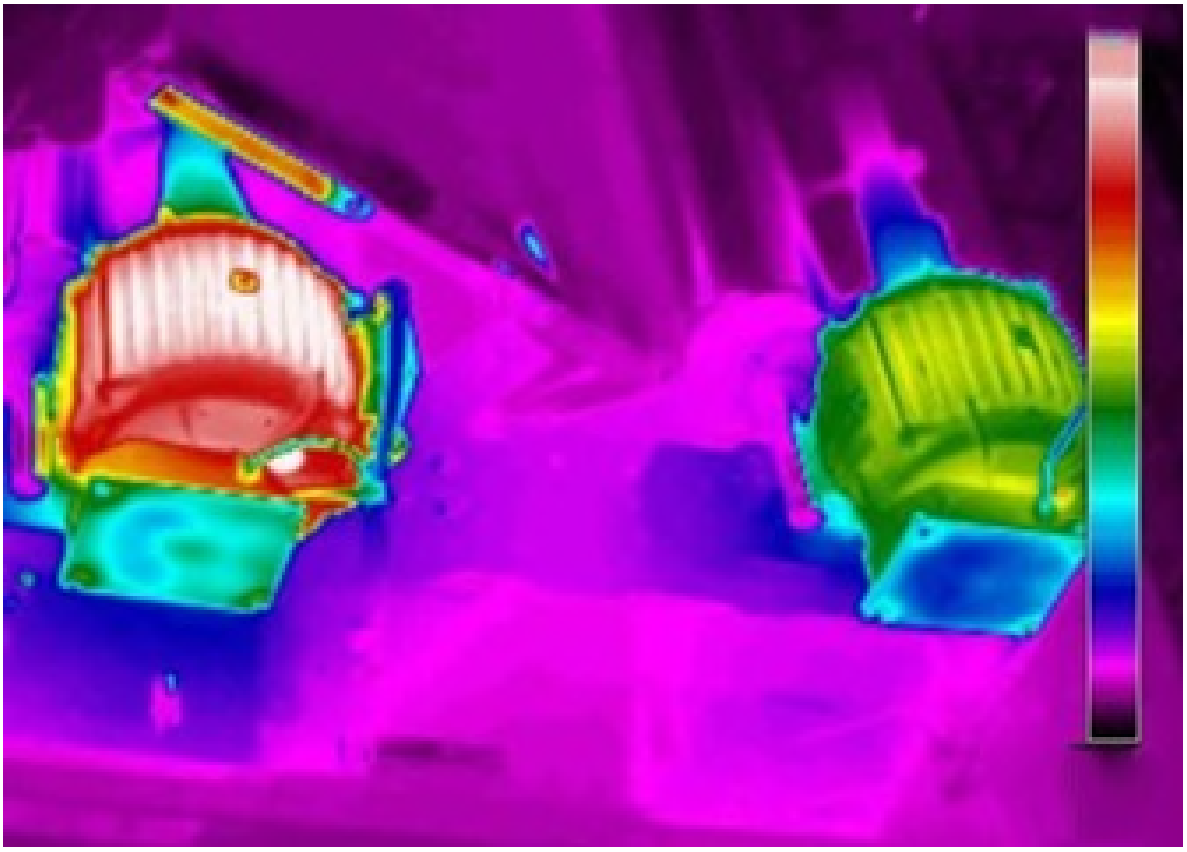




- Bearing heating up, possibly insufficient lubrication or alignment problem.

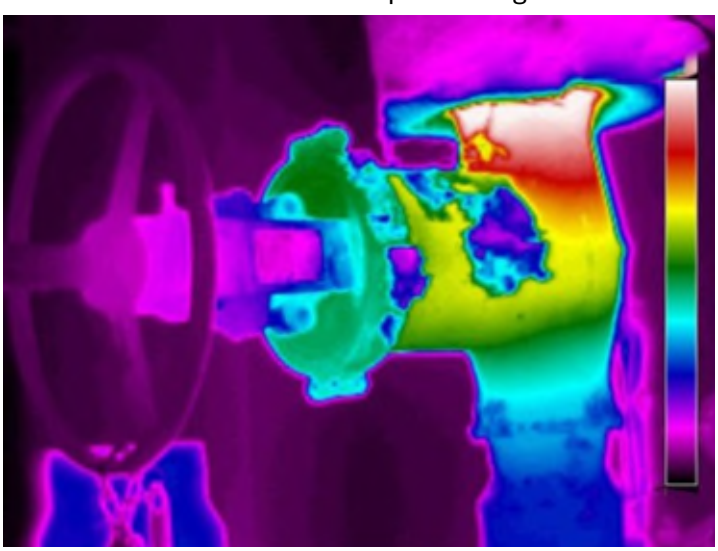


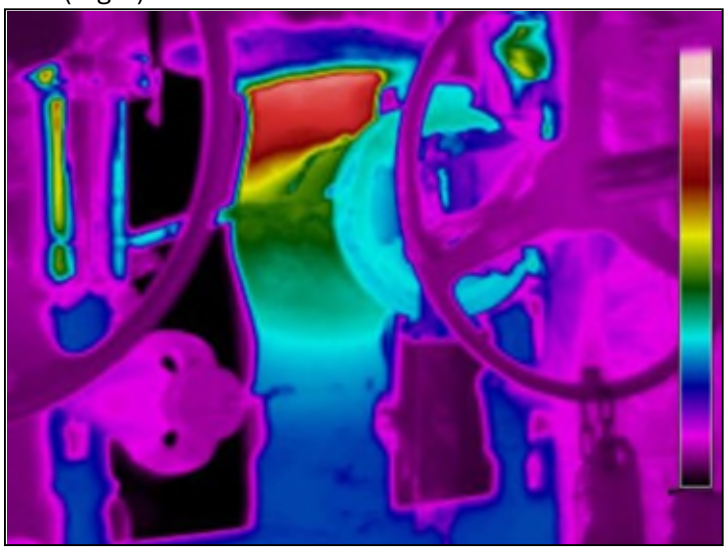
- Fault in left motor, compared to normal operation in right motor.



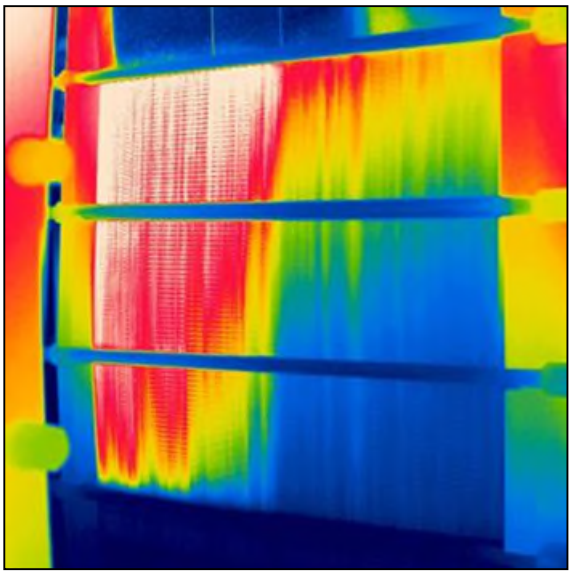
5. Appendix C: Operational examples

- Closed valve leaking internally. (left)
- Closed valve performing as should be. (Right)

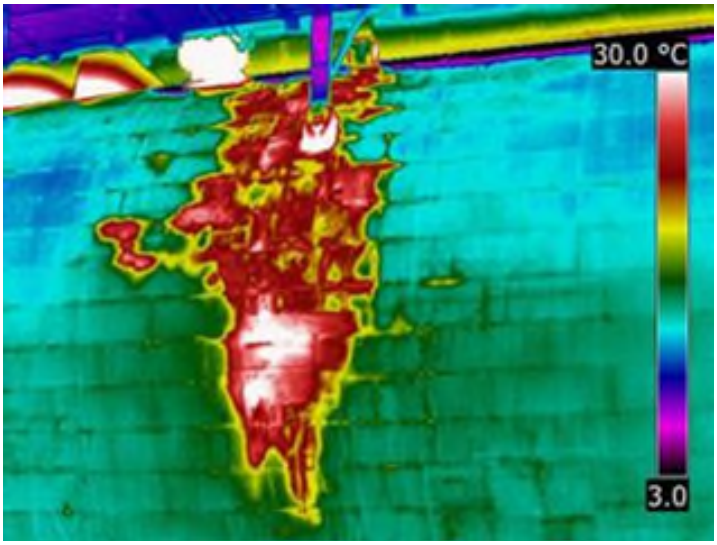


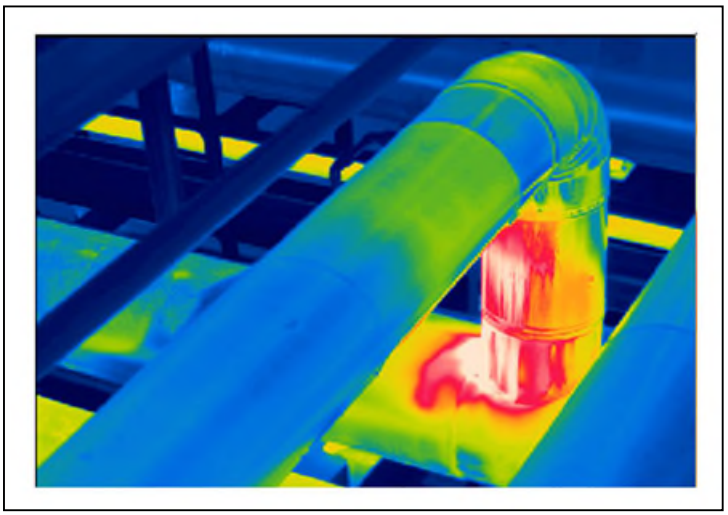


- Lost cooling capacity on cooler bank, possible blockage or flow problems.

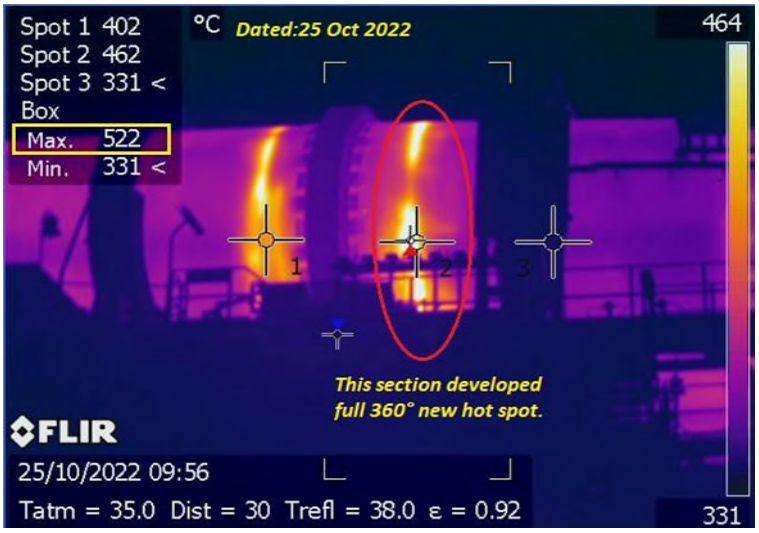


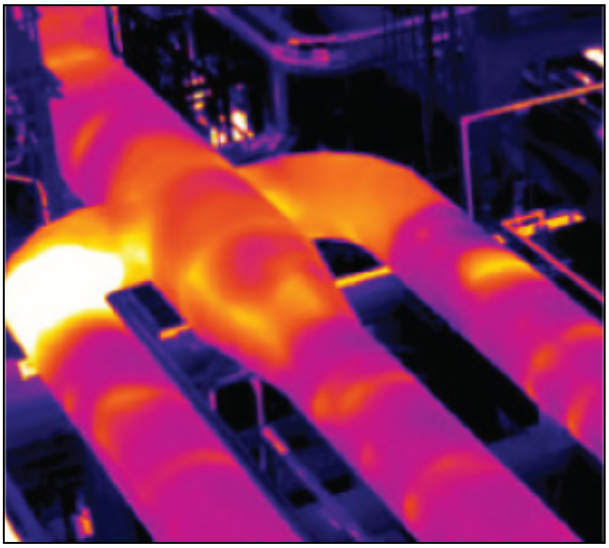
- Water retention under insulation. A major sign of corrosion under insulation (CUI)



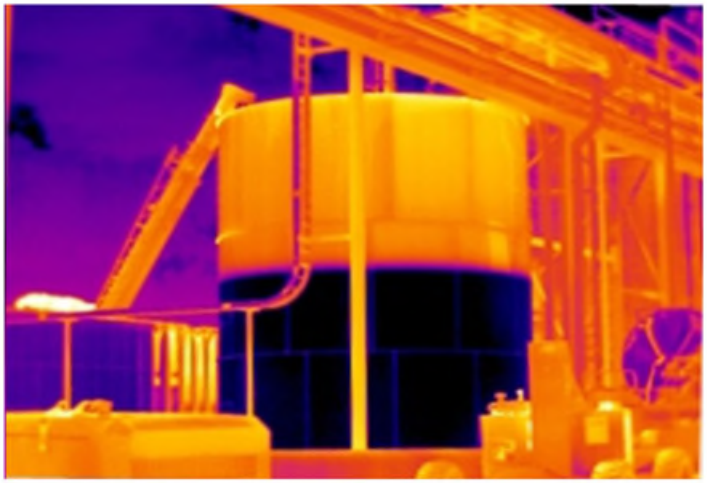


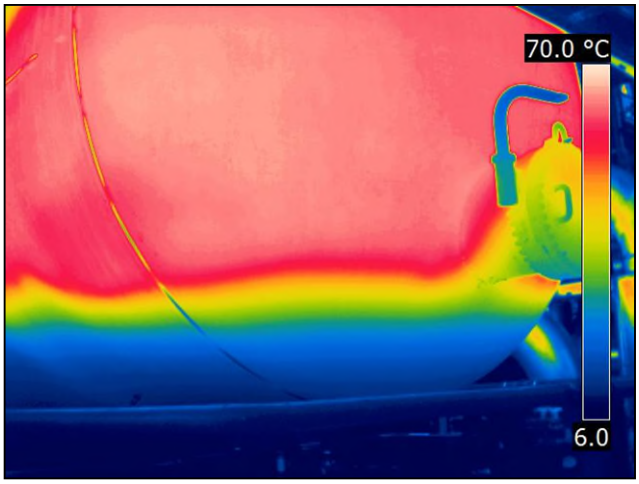
- Internal refractory damage





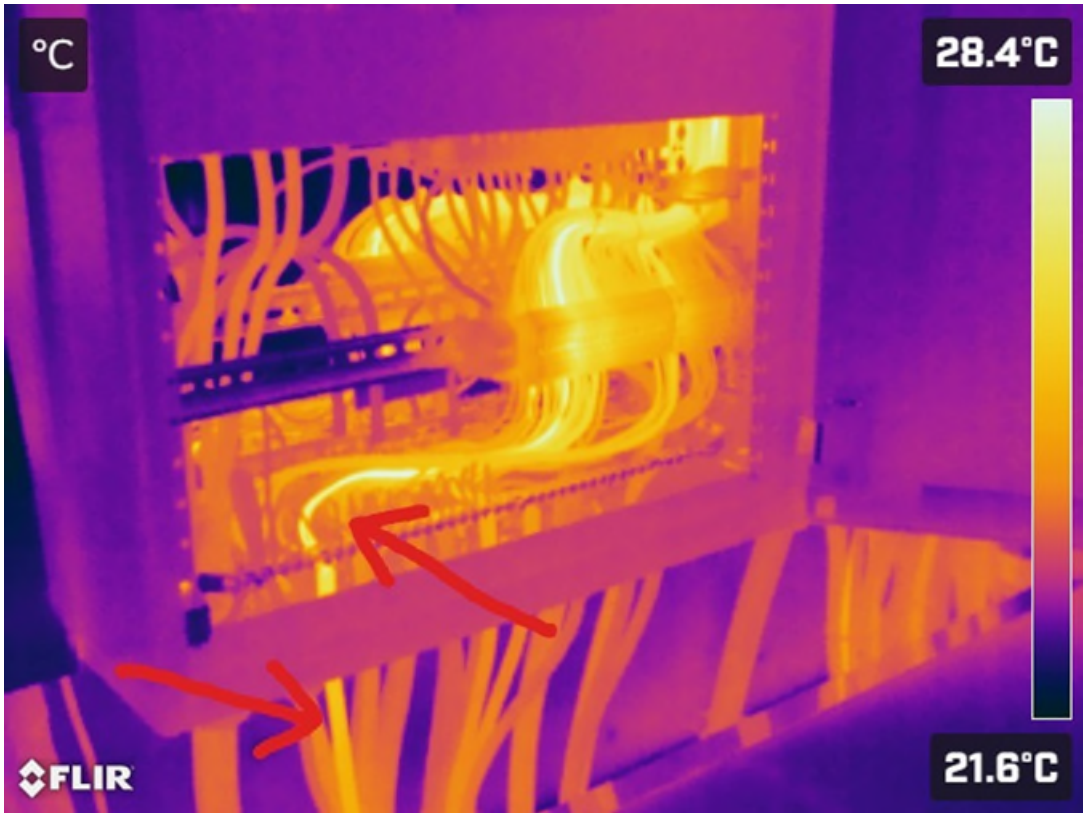
- Level detection in tanks (Left)
- Visualizing sediment inside a separator (Right)





6. Appendix D: Electrical examples

- Single wire overheating. Possible insulation failure.



- Increased resistance inside Ni-Cd battery cell during charging. Possible bad cell.