



Pall Corporation

Mi8, Mi17 and Mi24/35 Helicopters

Improving Reliability and
Availability



Lessons learned from Helicopter Operations in Desert Conditions

The harsh environment and hazardous conditions encountered during helicopter operations in Afghanistan led to significant problems for the Mi-8, Mi17 and Mi24/35 helicopters [1]

Airborne contamination would enter the helicopter engines and other fluid systems causing wear and damage to critical components. This resulted in operational problems, reduced Mean Time Between Unscheduled Removals (MTBUR) and higher maintenance costs.

For all the main helicopter fluid systems; engine air, engine fuel, engine lubrication, helicopter hydraulics and helicopter transmission, Pall Aerospace offers filtration and separation solutions, including filter upgrade kits.

Pall's solutions remove damaging contamination and this results in increased helicopter availability and improved flight safety.

Application bulletin

Problems with Helicopter Operations in Desert Conditions

Engine Air System (Inlet Air)

Main Problems

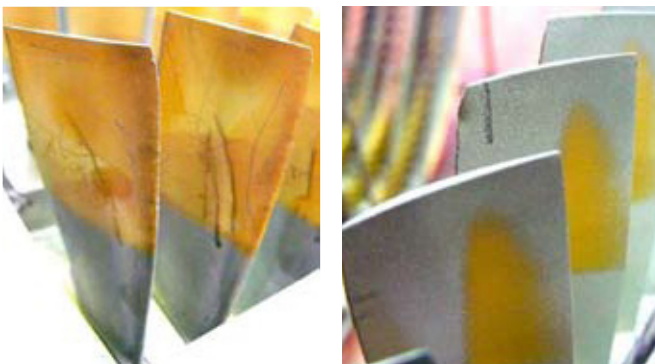
The harsh and hazardous conditions encountered during helicopter operations in Afghanistan are explained in Reference [1]. The presence of large amounts of airborne contamination, e.g. sand/dust, salt, moisture, etc. combined with unprepared landing strips, led to large clouds of sand and dust during helicopter landing/take-off and low altitude hover.

The helicopter engines (TV3-117) were most affected by these challenging operating conditions. They experienced engine wear and damage leading to operational problems including:

- Reduced engine reliability. Only 50% of the Mi-24 and 40% of the Mi-8MT engines were able to meet their regular overhaul intervals (Mean Time Between Overhauls, MTBO).
- Airframe damage during landings in brownout conditions
- Engine power loss (due to erosion)
- Risk of bird strike to engines
- Reduced hover capability and maneuvering capability

| Reason for premature removal of TV3-117 engines* | % |
|--|---------|
| Compressor blade erosion | 35...40 |
| Damage to compressor or turbine ducts | 20...25 |
| Nicks on compressor or turbine blades | 15...20 |
| Compressor stall or surge | 10...15 |
| Foreign object damage | 5...10 |
| Others | 0...5 |

*Adapted from Reference [1]



Compressor Blade Erosion

Solution

The fit and forget *PUREAir* system is the optimum solution for such challenging operations. It will **solve all the above reasons for premature engine removals** and offers the following benefits:

- Increased flight safety
- Improved engine power compared to the activated Dust Protection Unit (DPU) 'mushroom' separator system
- Enhanced protection against engine erosion
- Protection against Foreign Object Damage (FOD)
- Allows pilots to conduct brownout landings in the 'safest' way rather than the 'quickest' way
- Minimal Hot Gas Ingestion (HGI) and reduced power lost due to uniform airflow distribution
- All year round snow and ice protection

PUREAir for Mi24 and Mi35 helicopters



PUREAir for Mi-8 and Mi-17 helicopters



PUREAir for Mi-171 helicopters



Problems with Helicopter Operations in Desert Conditions

Engine Lube and Fuel Systems

Main Problems

The primary problems with the engine lubrication and fuel systems were caused by the ingestion of environmental contamination, e.g. sand/dust, salt and moisture. The sand/dust contamination was abrasive, while the combination with salt and moisture resulted in an abrasive and corrosive contaminant mixture. This caused **accelerated bearing and other component wear**, resulting in a **reduced MTBR for engine lube and fuel system** components. Operational problems included:

- Short life of fuel and lube filters (cleaned every 10 flight hours - normally every 90 to 120 hours)

Engine fuel control system

- Incorrect or un-commanded power changes of fuel control system
- Increased tendency for engine compressor stall (fuel controls do not react quickly enough to power changes)
- Differences in response and power between the two engines (no power matching)
- Stall or stagnation on start-up of the engine

Engine RPM

- Hang-up of the compressor and power turbine RPM
- Drift of the engine RPM at idle
- Lack of response to power demands by the pilot when the collective was raised, resulting in low rotor RPM
- Increase in T4 temperature causing the corresponding limiter to activate.

Solutions for the Engine Lube and Fuel System

The current fuel and lube filtration on the TV3-117 engine consists of cleanable, wire mesh filters (not supplied by Pall) which are not effective in contamination control. These filters have a low particle removal efficiency and a limited dirt holding capacity and quickly become clogged. **For the TV3-117 engine, Pall Aerospace has designed filter upgrade kits** that provide disposable, finer filtration.

These 'depth' type, disposable filter elements provide finer filtration with a high dirt holding capacity which reduces the number of filter blockage incidents. They eliminate the logistics and labour costs associated with ultrasonic cleaning of metal mesh elements. In addition, they eliminate the 'human factor' in achieving consistent quality in the maintenance and cleaning procedures. The filter element service life is expected to be 3-5 times longer than the existing metal mesh filters (hence less maintenance and system openings to atmosphere).

The use of Pall filtration solutions results in:

- Improved fluid system cleanliness
- Improved operating reliability and performance of the engine lube and fuel systems
- Extended component service life
- Extended oil service life due to cleaner oil
- Significantly reduced maintenance costs
- Increased flight safety and reduced risks of mission abort and accidental landings.

The differential pressure indicator actuation setting has been adjusted to provide additional time between filter differential pressure indication and actual filter element by-pass. Compared to the original filter system, this allows sufficient time for completion of the flight without having to abort and land immediately.



TV3-117 Engine Lube System



TV3-117 Engine Fuel Filter

Problems with Helicopter Operations in Desert Conditions

Transmission Systems

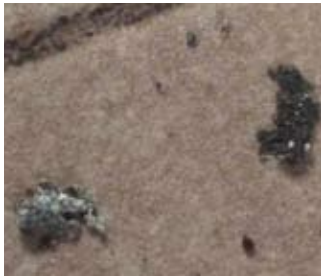
Main Problems

The main transmission was the system most affected by the high temperatures and airborne sand and dust in these conditions.

High particulate contamination levels in the B-3V transmission fluid **led to operational problems** including:

- Rapid wear of the gears and bearings
- Repeated cases of premature removal of the helicopter's main transmission due to metal chips in the oil
- Early filter blockage
- High incidence of false ('nuisance') chip detector indications, resulting in emergency landing of helicopters

False indications of the chip detectors is still a persistent issue with Mi-8/Mi-17 helicopters, even in other environments and in civil commercial operations [2]. The false indications are generated by fine metal particles from normal wear, sometimes called 'fuzz', that bridge the gap in the chip detector and activate it.



Mi-8/17 helicopter main gearbox.

Typical lube oil condition after few hours of operation with new oil.



Mi-8/17 helicopter main gearbox.

Lube oil condition after 20 min run with Pall filter retrofit kit.

Solution to Increase Reliability of Transmission Systems

For the Mi17 and Mi24/35 transmission system, a **filter upgrade kit is now available** to replace the cleanable, wire mesh filters which are not very effective in contamination control.

Trials at the OEM facility in Krasny Oktyabr [3] proved that the Pall filtration solution provides a **significant improvement in wear of gears and bearings**. The gearboxes fitted with the Pall filter upgrade kit had a significant decrease in scratches, cracks etc at the cogs of gears, bearings and gear races compared to those gearboxes fitted with 100 micron stacked disc metal filter.

The upgrade kit includes a 15 micron disposable filter element that is very efficient at cleaning up the transmission gearbox. The kit is qualified for both gearboxes; VR-14 (Mi-8/17 helicopter) and VR-24 (Mi-24/35 helicopter), and consists of spare filter elements, valve unit (incorporating by-pass and shut-off valves) and filter cavity cap with filter clogging indicator.

The benefits of finer filtration include:

- Increased flight safety
- Reduced 'nuisance' chip detector indications due to reduced 'fuzz' (fine debris) in transmission fluid
- Improved fluid system cleanliness and hence, improved system performance and extended component service life
- Improved operational reliability and increased transmission MTBR
- Reduced Maintenance Costs

Main gearbox lube filter kit



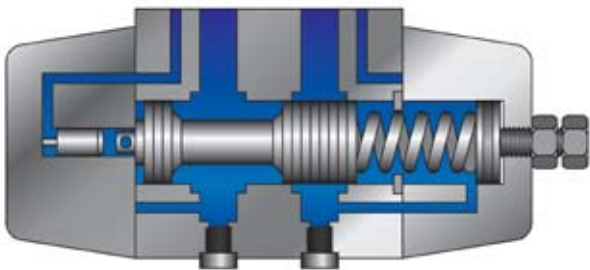
Problems with Helicopter Operations in Desert Conditions

Hydraulic Systems

Main Problems

When refilling the hydraulic system, the reservoir is open to the atmosphere and significant amounts of airborne dust can enter and contaminate the hydraulic fluid. Contamination can also originate from several other sources, e.g. component wear and dirt attaching to exposed actuator rods.

Dust and contamination will cause scoring, scratching, wear and corrosion and this degrades the hydraulic system performance.



Typical Valve Assembly.

Research and field experience has established that fluid contamination degrades the performance and life of hydraulic equipment. The effects include:

- Increased pump leakage, lower pump pressures and reduced efficiency
- Jerky valve movement, valve hysteresis, valve jamming
- Corrosion, high acid levels in hydraulic fluid
- Fluid Oxidation leading degradation in hydraulic fluid properties

Solution

Fine filtration removes harmful contaminants from the hydraulic system which results in:

- Improved fluid system cleanliness
- Improved operating reliability and performance of the hydraulic system and reduced MTBUR of components
- Significantly reduced maintenance costs (increased servicing intervals so no need for ultrasonic washing)
- Significantly reduced 'human factor' influence (e.g. opening and servicing the system)
- Increased flight safety



Mi8/17 Hydraulic filter assemblies

For the latest generation of Mi-8/17 family (Mi-171A2), a new hydraulic filter assembly and a reservoir breather are being introduced by Pall Aerospace. They are also available to retrofit the existing fleet.

On-ground, portable purifiers can also be used to remove water, gases and particulate contamination from the hydraulic fluid which can extend the fluid service life and reduce disposal costs

Problems with Helicopter Operations in Desert Conditions

Conclusions and Recommendations

The harsh environment and operating conditions in Afghanistan led to significant contamination related problems. The following solutions are available to improve the reliability and availability of Mi8, Mi17 and Mi24/35 helicopters:

PUREAir for protection of engine inlet air.

This self-cleaning system will minimize engine erosion, corrosion and FOD damage, resulting in increased engine reliability and improved flight safety.

Filter upgrade kit for engine lube and fuel systems

Incorporation of fine filtration will prevent wear of pumps, valves and bearings, resulting in increased system reliability and proper fuel controls operation.

Filter upgrade kit for transmission systems

Incorporation of fine filtration will prevent wear on the transmission bearings and gears and accumulation of 'fuzz' in chip detectors, resulting in increased system reliability and minimizing 'nuisance' chip detector indications.

Filter upgrade kit for hydraulic systems

Incorporation of fine filtration will prevent wear of pumps, valves and actuators, resulting in increased system reliability and improved performance of flight controls.

For more information visit www.pall.com/pureair



Pall Global Helicopter Support



Engineering

Designing a fluid filtration system is a complex process that requires significant knowledge and experience. Every filter design is tailored to a specific helicopter model.

Pall's design and engineering expertise ensures that optimum performance is achieved in the smallest envelope with the lowest weight possible.

Scientific and Laboratory Services

A principal element in Pall's customer support operations is our Scientific and Laboratory Services (SLS) group. Pall's scientists and application specialists work closely with customers to understand the systems and analyse any problems experienced. Technical support includes contamination analysis, troubleshooting, filter element service life optimisation, seminars and training

Research and Development

Pall has a policy of continual research and development. It has developed an array of core materials and technologies that can be combined and manipulated in many ways to solve complex fluid separation challenges.

Sales and Support Services

Pall Aerospace has sales offices and representatives in Europe, the Middle East, Asia, North and South America.

We offer a comprehensive sales and service support to all manufacturers and operators of MIL helicopters, wherever their location.

References

- [1] A.M. Volodko, V.A. Gorshkov, 'Helicopters in Afghanistan', Edited by: Honoured Scientist of Russian Federation Dr.Prof. A.M. Volodko, published by Moscow Military Publishing House, JSC 'REAM-Building'
- [2] Technical report of FSUE 'GosNIIGA', Incident analysis of Mi-8 and Mi-8MTV-1 (Mi-8AMT) helicopters occurred in 2003-2004 by civil aviation of Russia.
- [3] 'Pall lube filter testing within VR-14 gearbox at Krasny Oktyabr', "Pall lube filter testing within VR-24 gearbox at Krasny Oktyabr"



Pall Aerospace

New Port Richey, FL - USA
+1 727 849 9999 telephone
+1 800 933 3111 toll free US


Portsmouth - UK
+44 (0)23 9233 8000 telephone
aerospace@pall.com



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