AI-450M (M1, M2)  AI-450M-E (M1-E, M2-E)  AI-450-2

Turboshaft gas turbine engines

Designed to power multi-purpose helicopters
## CORPORATION ‘NPO ‘A.IVCHENKO’

**YEAR OF CORPORATION ESTABLISHMENT - 2007**

<table>
<thead>
<tr>
<th>Sphere of activity</th>
<th>1907 - Creation of Motor Sich JSC</th>
<th>1945 - Creation of Ivchenko-Progress SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development, production and overhaul of gas-turbine engines for civil and military aviation, industrial gas-turbine drives and power-generating plants, consumer goods.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structure</th>
<th>14 structural units located in different parts of Ukraine as well as in China, India, UAE, Algeria</th>
<th>one structural unit located in Zaporozhye</th>
</tr>
</thead>
</table>

| Number of employees | over 21 000 | 3 100 |
**AI-450 ENGINE FAMILY**

**AI-450M (M1, M2) Turboshaft**

**AI-450M-E (M1-E, M2-E) Turboshaft**

**AI-450BP, AI-450BP-2 Turbofan**

**AI-450C (CM, CD, CP) Turboprop**

**AI-450C-2 (CP-2) Turboprop**

**AI-450-2 Turboshaft**

- \( N_{\text{shaft}} = 400...465 \text{ hp} \)
- \( N_{\text{shaft}} = 530...550 \text{ hp} \)
- \( N_{\text{shaft}} = 465 \text{ hp} \)
- \( N_{\text{shaft}} = 630...800 \text{ hp} \)
- \( N_{\text{prop}} = 400...495 \text{ hp} \)
- \( N_{\text{prop}} = 630...800 \text{ hp} \)
- \( R = 400...560 \text{ kgf} \)
POSSIBLE APPLICATION OF AI-450 ENGINE AND ITS MODIFIED VERSIONS

Mi-2M, MSB-2

Helicopters with takeoff weight of 3000...3300 kg

AI-450M, AI-450A-E

Perspective helicopters

AI-450M1, AI-450M2, AI-450A1-E, AI-450A2-E
AI-450M1
# AI-450M (M1, M2), AI-450M-P (M1-P, M2-P) MAIN DATA

**S/L static, ISA; unpacked**

<table>
<thead>
<tr>
<th>Engine models</th>
<th>AI-450M (M1, M2)</th>
<th>AI-450M-P (M1-P, M2-P)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Takeoff</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- power, hp</td>
<td>400</td>
<td>465</td>
</tr>
<tr>
<td>- specific fuel consumption, kg/h/hp</td>
<td>0.280</td>
<td>0.270</td>
</tr>
<tr>
<td><strong>Max cruise</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- power, hp</td>
<td>285</td>
<td>300</td>
</tr>
<tr>
<td>- specific fuel consumption, kg/h/hp</td>
<td>0.320</td>
<td>0.312</td>
</tr>
<tr>
<td><strong>Dimensions and weight</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- width, mm</td>
<td>534</td>
<td></td>
</tr>
<tr>
<td>- height, mm</td>
<td>648</td>
<td></td>
</tr>
<tr>
<td>- length, mm</td>
<td>1115</td>
<td></td>
</tr>
<tr>
<td>- weight, dry, kg (in accordance with GOST 17106-79 State Standart)</td>
<td>115</td>
<td></td>
</tr>
</tbody>
</table>
PERFORMANCE

S/L static, ISA

Specific fuel consumption, kg/h/hp

Propeller shaft power, hp
PERFORMANCE

Takeoff

- Engine inlet air temperature, °C
- Shaft power, hp

- H = 3000 m, $A_{\text{amb}} = 70.1$ kPA

- $H=0$ Hi-450H (H1-P, M2-P)
- $H=0$ Hi-450H (H1, M2)
PERFORMANCE

Shaft power, hp

Engine inlet air temperature, °C

H = 3000 m, $A_{\text{amb}} = 70.1$ kPa

H = 3000 m, $A_{\text{amb}} = 70.1$ kPa

S/L, ISA

H=0 Hi-450H (H1-P, M2-P)

H=0 Hi-450H (H1, M2)
PERFORMANCE

Takeoff

Fuel consumption, kg/h

Engine inlet air temperature, °C

H = 3000 m, $A_{amb} = 70.1$ kPa

S/L, ISA

H=0 Hi-450H (H1-P, M2-P)
H=0 Hi-450H (H1, M2)

Ukrainian Defence Industry
**AI-450M-E (M1-E, M2-E) MAIN DATA**

S/L static, ISA; uninstalled

<table>
<thead>
<tr>
<th>Takeoff</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- power, hp</td>
<td>550</td>
</tr>
<tr>
<td>- specific fuel consumption, kg/h/hp</td>
<td>0.273</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Max cruise</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- power, hp</td>
<td>400</td>
</tr>
<tr>
<td>- specific fuel consumption, kg/h/hp</td>
<td>0.310</td>
</tr>
</tbody>
</table>

**Dimensions and weight**

| - width, mm                     | 534   |
| - height, mm                    | 648   |
| - length, mm                    | 1115  |
| - weight, dry, kg (in accordance with GOST 17106-79 State Standart) | 115   |
AI-450M (M-P, M-E) LONGITUDINAL SECTION VIEW
AI-450M1(M1-P, M1-E) LONGITUDINAL SECTION VIEW
DESIGN FEATURES

The AI-450M (M1, M2, M1-E, M2-E) turboshaft engines have a two-rotor design consisting of a gas generator rotor and free turbine rotor. The free turbine transmits power to the reduction gear, arranged in front of the engine, through the shaft passing inside the gas generator rotor shaft.

Each rotor is mounted on two bearing supports built in the engine stator. To obtain the required engine vibration characteristics the gas generator rotor front bearing support and free turbine rear rotor bearing support are carried on elastic-oil dampers.

The engine consists of three modules:

- Reduction gear with accessory gearbox built in the same casing;
- Gas generator containing inlet section, compressor, combustion chamber and compressor turbine;
- Free turbine with its shaft.

Reduction gear is of two-stage design with non-axial configuration with a gear ratio of 6.5:1. Axial force arising in the running block helical gear is transmitted to the torquemeter pistons. The driven and non-driven accessories are mounted on the reduction gear and accessory gearbox casing.

The parts of the AI-450M (M-E) and AI-450M1 (M1-E) reduction gears are completely unified, and on AI-450M2 (M2-E) engine the reduction gearbox is unified with the baseline AI-450 engine.

Compressor is of single-stage design containing a high-pressure centrifugal wheel, radial vaned diffuser and axial stator blades. The compressor front casing is the engine basic load-carrying structure where the gas generator rotor front bearing support is arranged.

Combustion chamber is of annular type, return-flow design with a low NOx emission level. To reduce the engine length the combustion chamber flow section is turned by 180°.

Compressor turbine is of a supersonic single-stage design with cooled nozzle vanes and rotor blades made of heat-resistant alloy.

Free turbine is of axial, single-stage design, uncooled.

The engine-to-helicopter attachment is of two-planar type: in front plane by two horizontal trunnions mounted on the reduction gear casing, and in rear plane by two eye-lugs in joint between the combustion chamber casing and jet nozzle.

The materials of parts and special coatings enable the engine to be operated under all climatic conditions.

The engine control system, which provides two variants of adjustment by power under the basic engine performance ratings, is electronic, double-channel with the added hydromechanical redundant channel. The engine operation monitoring and diagnostics are carried out by means of airborne and ground monitoring equipment in accordance with parameters transferred by engine sensors and indicators.
AI-450-2 ENGINE
AI-450-2 MAIN DATA

2.5 min OEI rate, S/L static; ISA
- output shaft power, hp, not less ............................................................750
  (flat rated up to $t_{amb}=+30^\circ C$)
30 min OEI rate, S/L static; ISA
- output shaft power, hp, not less ............................................................660
  (flat rated up to $t_{amb}=+30^\circ C$)
Takeoff, S/L static; ISA
- output shaft power, hp, not less .............................................................630
  (flat rated up to $t_{amb}=+35^\circ C$)
Max cruise, S/L static; ISA
- output shaft power, hp, not less .............................................................450
  (flat rated up to $t_{amb}=+30^\circ C$)
- specific fuel consumption, kg/h/kgf......................................................0.294

Dimensions and weight
Length, mm.................................................................1149
Width, mm............................................................520
Height, mm............................................................567
Weight, dry (according to GOST 17106-79 State Standard), kg, not more...125
CHARACTERISTICS

S/L static, ISA
according to GOST 4401-81 State Standard

Output shaft power, hp

Specific fuel consumption, kg/h/hp
CHARACTERISTICS

S/L static, ISA

Output shaft power, hp

Ambient air temperature, °C

$N_{\text{shaft}}$ 2.5-minute emergency

30-minute emergency

Takeoff
CHARACTERISTICS
Static, ISA
according to GOST 4401-81 State Standard

Output shaft power, hp

Takeoff
30-minute emergency
2.5-minute emergency

Altitude, m

N_{shaft}
The AI-450-2 is a turboshaft engine with a free single-stage turbine driving the output shaft via the reduction gear combined in with the accessory gearbox the same casing. Driving of auxiliary accessories is carried out from the gas generator rotor. The engine gas-generator consists of a single-stage centrifugal compressor, reverse-flow annular combustion chamber, single-stage compressor turbine.

The gas generator rotor is mounted on two bearing supports: front ball bearing support and rear roller bearing support. For decreasing the total level of vibrations and stresses a damper with elastic ring is introduced in the front bearing support. The free-turbine rotor is mounted on two supports: front support with combination of roller bearing and ball bearing for taking axial loads, and rear support with roller bearing. An elastic oil damper is used in the free turbine rotor rear bearing support.

**The engine consists of three modules:**
- Reduction gear with accessory gearbox built in the same casing;
- Gas generator containing inlet section, compressor, combustion chamber and compressor turbine;
- Free turbine with its shaft.

**Reduction gear** is of two-stage design with non-axial configuration with a gear ratio of 5.8:1. The driven and undriven accessories (starter-generator, fuel-metering unit, oil pump block and centrifugal breather) are fitted to the reduction gearbox casing.

**Compressor** is of single-stage design containing a high-pressure centrifugal wheel, radial vaned diffuser and axial stator blades. The compressor front casing is the engine basic load-carrying structure where the gas generator rotor front bearing support is arranged.

**Combustion chamber** is of annular type, return-flow design with a low NOx emission level. To reduce the engine length the combustion chamber flow section is turned by 180°.

**Compressor turbine** is of a supersonic single-stage design with cooled nozzle vanes and rotor blades made of heat-resistant alloy.

**Free turbine** is of axial, single-stage design, uncooled.

The engine-to-helicopter attachment is of two-planar type: in front plane by two horizontal trunnions mounted on the reduction gear casing, and in rear plane by two eye-lugs in joint between the combustion chamber casing and jet nozzle.

The materials of parts and special coatings enable the engine to be operated under all climatic conditions.

**The engine control system** is electronic, two-channel with the additional redundant hydro-mechanical channel. The engine operation monitoring and diagnostics are carried out by means of airborne and ground monitoring equipment in accordance with parameters transferred by engine sensors and indicators.
01 - Gas generator
02 - Free turbine rotor
03 - Outlet diffuser
04 - Reduction gear
AI-450M (M-P, M-E) DIMENSIONS

Engine attachment front plane (FAP)
Engine attachment rear plane (RAP)
AI-450M1 (M1-P, M1-E) DIMENSIONS

Engine attachment front plane (FAP)
Engine attachment rear plane (RAP)

Dimensions:
- Engine attachment front plane (FAP): 243 from FAP
- Engine attachment rear plane (RAP): 230.5 ± 0.3
AI-450M2 (M2-E) DIMENSIONS

Engine attachment front plane (FAP)
Engine attachment rear plane (RAP)
AI-450M2 MOUNTING AND RIGGING DIAGRAM

Engine left-side view

FAP

558

RAP

A

B

Starboard engine mounting diagram

Port engine mounting diagram

Front rigging bracket

235

269

250

250

235

448

448

290

290

Aircraft mounting points

Helicopter axis

Front mounting trunnion

C section view

Front rigging bracket

Rear rigging bracket

Rear mounting bracket

Engine attachment front plane

18

4.5
AI-450-2 DIMENSIONS

Engine front attachment plane (FAP)
Engine rear attachment plane (RAP)

Shaft axle is a spring
AI-450-2 MOUNTING AND RIGGING DIAGRAM
## AI-450M, AI-450M-E, AI-450-2 RELIABILITY

<table>
<thead>
<tr>
<th>Design indices of trouble-free operation in service:</th>
<th>( T_{\text{fl std}} &gt; 50000 , \text{h} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>- mean time between engine shutdown in flight</td>
<td>( T_{\text{unsch}} &gt; 10000 , \text{h} )</td>
</tr>
<tr>
<td>- mean time between unscheduled engine removal</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Service life:</th>
<th>3000 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>- to 1\textsuperscript{st} overhaul and T.B.O.</td>
<td>12000 h</td>
</tr>
<tr>
<td>- assigned</td>
<td></td>
</tr>
</tbody>
</table>
SAFE OPERATION SUPPORT

The AI-450M-E (A1-E, M2-E), AI-450-2 safe operation is ensured by:

1. Certification of compliance with AP-33 (FAR-33) Aviation Rules for power jets.
2. Airworthiness support within overall engine life cycle.
3. Aftersales support including:
   - maintenance within guaranteed period;
   - post-guaranteed maintenance;
   - logistical support;
   - flight and technical personnel training;
   - development of operation and technical documents and their application;
   - engineering support;
   - informational support;
   - organizational activities.
AUTOMATIC CONTROL SYSTEM

The engine automatic control and monitoring system (ACMS).
The control of all engine performance ratings under all conditions in operation is supported by a double-channel electronic digital control as combined with the engine sensors and actuators, and also by helicopter airborne systems. The functions of the automatic control system (ACS) are performed in the amount the same for both variants of power adjustment under the basic performance ratings of the engine.

ACMS composition:
1. Engine digital control (РДЦ-450М) with included self-contained functional modules:
   - free turbine automatic protection (А3СТ);
   - vibration monitoring (МКВ);
   - parameter monitoring (МКП);
2. Fuel-metering pump (НД-450М)
3. rotational speed governor (РО450М)

The ACMS main functions:
- control of the engine accessories for conducting the engine start, cold cranking and false start (preservation and depreservation);
- automatic support of a free turbine rotational speed (with the basic and redundant hydromechanical ACMS);
- control of fuel consumption under stable and variable performance ratings of the engine;
- limitation and protection of engine against exceeding of accepted parameters;
- protection against overspeeding by using an independent automatic protection system;
- synchronization of the engine power in a twin-engined powerplant under stable performance ratings;
- engine shutdown;
- information interaction with the engine systems and helicopter airborne systems;
- monitoring of the ACMS integral parts and interacting items with differentiation of malfunctions detected;
- automatic reconfiguration of the ACMS according to the results of malfunctions detected (including a transfer to a redundant hydromechanical ACMS);
- record of information in the РДЦ-450М nonvolatile internal recorder about malfunctions detected;
- introduction and storage of operational adjustments and individual features of the engine.
Our engines are operated in more than 100 countries of the world.
Zaporozhye Machine-Building Design Bureau
Progress State Enterprise named after
Academician A.G. Ivchenko

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69068, Zaporozhye, Ukraine
Tel.: (+38 0612) 65-03-27;
Fax (+38 0612) 12-89-22, 65-46-97
progress@ivchenko-progress.com
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