



Technical Specification for inlet guide vanes of axial flow compressor

Ref. : 002-TML-2017-IGV

Dt. : 15.03.2017

Rev. no.: 01

1. SCOPE OF WORK:

The scope of work is to manufacture and supply of inlet guide vanes (IGV) of axial flow compressor as per the manufacturing drawing (No. RD DG3 TM16 01) and solid model provided by BHEL. Delivery, packing, forwarding & unloading of the IGVs at BHEL R & D, Hyderabad is also included in the scope of work.

2. MATERIAL:

The IGV shall be manufactured from steel grade X3CrNiMo13 4 as per the material specification given below:

The precision forged blades shall be supplied in hardened and tempered condition. The blades shall be thoroughly cleaned by shot blasting and flash shall be removed completely.

2.1 MANUFACTURE:

The steel shall be manufactured from basic electric furnace. The forgings shall be made as envelope forging or precision forgings subsequently machined ground to achieve the dimensions and surface finish as per ordering drawing.

2.2 HEAT TREATMENT:

Following heat treatment is suggested.

- Hardening temperature shall be between 950-1050 ° C followed by quenching in air or oil.
- Tempering temperature shall be 560-640 ° C and cooling from tempering temperature shall be slow enough to minimise residual stresses.
- If necessary, heat-treated blades can be straightened. And all straightened blades shall be stress relieved. The stress relieving temperature shall be 20-30 ° C below the actual tempering temperature.
- The actual heat treatment parameters like temperature, rate of heating, soaking time and rate of cooling shall be submitted to BHEL.
- Number of reheat treatments shall not exceed two. However, re-tempering is not considered as reheat treatment.

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2.3 FINISH:

The surface finish of the forgings shall be as per the manufacturing drawing.

2.4 FREEDOM FROM DEFECTS:

The blades forgings shall be free from cracks, laps and other harmful defects.

2.5 CHEMICAL COMPOSITION:

The Chemical composition of the material shall be as follows.

Element		C	Si	Mn	Cr	Ni	Mo	S	P	N
Melt Analysis	Min	--	--	--	12.00	3.50	0.30	--	--	0.020
	Max	0.05	0.70	1.50	14.00	4.50	0.70	0.015	0.040	--
Percentage Variation in product analysis		+0.01	+0.05	+0.04	± 0.15	± 0.07	-0.03 +0.05	+0.003	+0.005	--

2.6 SELECTION OF TEST SAMPLES FOR MECHANICAL & METALLOGRAPHY TEST:

a) All the blade forgings after heat treatment shall be tested for brinell hardness to determine the hardest and softest blade per melt per heat treatment batch. The Mechanical and Metallography tests shall be conducted on the hardest and softest blades of each melt & heat treatment batch as per Cl.8.2.

b) The number of sample blades for each melt and heat treatment batch shall be as follows.

For a batch size of less than or equal to 50 nos : One blade sample (having lowest hardness). For a batch size of > 50 nos : Two blade samples (one each of highest and lowest hardness).

c) The supplier may use the dimensionally rejected blades which have been heat treated along with other dimensionally accepted blades and meet the above given conditions of hardness as per batch size.

d) The supplier has the option of selecting sub-size specimens, if required. The properties of sub-size impact specimen shall be as per cl.9 of this specification.

e) Supplier shall submit the sketches of blades showing the test specimen locations for approval by BHEL before tests are conducted by them.

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2.7 MECHANICAL PROPERTIES:

Test samples shall conform to the following properties at room temperature.

Tensile Strength N/mm ²	0.2 % Proof stress N/mm ² Min.	% Elongation L=5d Min.	Impact strength ISO -V Notch	
			Specimen size	Joules. Avg.Min.
780-980	620	15	Full size, 10mmX10mm	70
			3/4th size, 10mmX0.5mm	53
			1/2 size, 10mmX5.0mm	35
			1/4th size, 10mmX2.5mm	18

NOTE: 1. Tensile test shall be done as per IS 1608 or any reputed national standard.

2. The charpy impact test shall be performed on a ISO-specimen (2 mm V notch) as per IS:1757 on any reputed national standard. The impact strength value indicated above is average of 3 values. Only one value can be lower than the minimum specified value but not less than 2/3 of the same. All the three values shall be reported.

3. Variation in hardness shall be 30 BHN maximum for a heat treatment batch.

2.8 NON-DESTRUCTIVE TEST:

Ultrasonic testing (on bars to be used for forgings).

- All the bars shall be ultrasonically tested according to pulse echo-method with frequency 2 or 4 MHz.
- DGS method shall be used for evaluation of the indications.
- The following indications shall not be permissible.
 - Individual indications scattered at random with an equivalent flaw size ≥ 2 mm dia.
 - All the indications with more than 10% loss in back echos.
 - All the indications linear or globular forming cluster, with an extension greater than 10 mm in any direction.
 - Local accumulation of indications with an equivalent flaw size ≥ 1 mm dia.

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d) MAGNET PARTICLE INSPECTION:

Each blade shall be subjected to MPI as per ASTM A275. No cracks are acceptable.

2.9 METALLOGRAPHIC TESTS:

- a) **Microstructure:** The microstructure shall be studied on the fractured tensile/ impact specimens and the photo micrographs shall be furnished to BHEL. The microstructure shall have a uniform tempered martensite structure with grain size No. 5 or finer as per ASTM E112
- b) **Non-metallic Inclusion:** non-metallic shall be evaluated as per ASTM E45, plate III the inclusion rating shall not exceed the following norms.

'A' Sulphide type : Thin series 2

'B' or 'D' Globular type Oxide : Thin series 2

'C' Silicate type : Thin series 2

However, anyone of the above can be allowed upto 2.5, provided the other two do not exceed 2.

- c) **Decarburisation tests:** The test for decarburisation shall be carried out by measurement of hardness, HV 0.3 at 0.1 mm below the surface. The hardness at these places shall not be less than 90% of the core hardness. The test shall be carried out at 1/3rd distance from the blade tip.

Alternatively decarburisation can be tested metallographically. In case of doubt hardness measurements shall be decisive.

2.10 RETEST

If any of the selected test specimens fail to meet the specified requirement due to some mechanical reasons, another specimen may be taken for testing.

In the event of failure due to heat treatment, not more than two reheat treatment shall be permitted.

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3.0 TEST CERTIFICATE: A) The supplier shall furnish three copies of the certificate containing the following details: a) BHEL Order No. b) Item Description c) Drawing No. d) Supplier's name e) Melt No. f) Heat treatment details g) Results of all tests stipulated in this specification. B) The test certificates shall be signed by the chief of the Inspection/chief metallurgist of the supplier and attested by BHEL's representative. 4.0 MARKING AND PACKING: The following details shall be punched clearly on each forging and the same shall be encircled by paint. a) Melt No. b) Serial No. of the forging The forging shall be suitably packed to prevent from damage and corrosion during transit. In case of imported forging, the packing shall be seaworthy. 5.0 INSPECTION: • Profile contour should be checked by the vendor using CMM for at least 3 cross sections (A, B & C as per drawing) along vane height for min. 5 blades and coordinate data should be generated to superimpose on the vane solid model provided by BHEL. Dimensional deviation more than ± 0.2 mm is not acceptable. • Dye penetration test should be carried out by the vendor. • BHEL shall conduct any stage wise inspection as required and vendor shall communicate the same. • Material shall be dispatched only after clearance from BHEL.		
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6. GENERAL:

1. The guide vane along with the spindle should be manufactured per the manufacturing drawing (No. RD DG3 TM16 01) considering the vane profile contours as per the solid model provided by BHEL.
2. Minor changes may be incorporated in the drawing (No. RD DG3 TM16 01) and solid model supplied during execution of the job.
3. Vendor should get clarified from BHEL, for any ambiguity found in the drawing or in the solid model, before proceeding further.
4. Stress relieving after machining as required shall be done by the vendor.
5. IGV blades are to be supplied with rust preventive coating on all the surfaces after proper cleaning and degreasing of the surfaces.
6. Vendor should quote price of the single IGV blade considering the total no. the blade to be supplied as 28.
7. Any defect in the manufacturing/ fabrication of the IGVs identified during assembly shall be rectified by the vendor without any cost to BHEL. Also, associated disassembly, transport, machining, rework and re-assembly will be under the vendor's scope of work.
8. Vendor must submit dimensional report along with all the finished product.
9. Vendor should submit the material test certificate along with the finished product.

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