

**Using API-617 as a Purchase Specification
for Centrifugal Compressors**

Although they are not legal documents, the various standards compiled and issued by the American Petroleum Institute (API) reflect the experience and recommendations of both users' and manufacturers' groups. These groups wish to impart safety and reliability to equipment utilized in the hydrocarbon processing industry (HPI). Of the two most important standards used in procuring dynamic compression machinery, API-617 pertains to centrifugal compressors and API614 applies to lubricating-oil systems. Virtually all API standards require users to make decisions on clauses marked with bullets (•), and understanding the standards is important for all parties. Therefore, highlighting a few clauses with explanatory remarks will be helpful in using the 7th Ed. (2002) API-617. (It should be noted that the numeric designation of a certain clause may change as the API Standard undergoes progressive updating or revisions.)

Clauses(s)	Topic	API Explanation	Remarks
1.5.18 through 1.5.26	Definition of normal speed, 100% and maximum continuous speed, plus others of interest.	The speed needed to attain the highest head at any operating condition. If the speed at the normal point is capable of meeting all the requirements at the other operating conditions, normal speed will be taken as 100% speed.	The definitions help to flush out any anomalies in deciding the shop performance test parameters. "MCS" or maximum continuous speed is 105% of the highest speed required to meet any of the specified operating conditions. This sets the values for the mechanical performance test and the over-speed test. It is

			important from the point of view inspection and NDT examination.
1.5.25	Normal operating point	The point at which usual operation is expected and optimum efficiency is desired.	
	Rated Point	Obtained by the intersection of 100% speed line and highest capacity during operation	Important to identify before ordering or before approval of inspection documents. Definition of guarantee point is required.
1.5.30	Stability	Stability is the difference in capacity between rated capacity and surge point at rated speed.	Important criterion for the design of the anti-surge system and for defining operating flexibility.
1.5.51	Turndown	Turndown is the percentage of change in capacity between the rated capacity and surge point capacity at rated head with unit operating at rated suction temperature and gas composition.	The amount of recycle volume and thus loss of power at low-flow operating conditions will be an important factor when it comes to a continuous mode.
1.5.39	Settling-out pressure	Pressure of compressor system when the machine is shut down.	It is important to state the same when handling gas that has substantial change in the vapor

			pressure for a small change in the temperature.
1.6.1	Referenced Publications	Identifies major standards covering driver, pressure vessels, instrumentation, electrical equipment, auxiliary equipment, auxiliary systems, piping, and material specifications	Look for completeness and keep deviations from applicable standard to bare minimum. Apply piping standards without compromising good layout; access; pipe supports; upstream interstage, and downstream piping; drains; platform; and grating. Be especially vigilant in instances in which the compressor is delivered as a standard package. On many occasions, comments start pouring in after contract award. Note that similar considerations should apply to instrument tubing and piping. Note cabling, junction boxes, and fire protection systems for which the user company may have

			developed an overall strategy based on decades of field experience. These strategies may be more comprehensive than those of the compressor manufacturer.
2.1.1.3	Acceptance Criteria	No negative tolerance on the capacity and head at normal point of operation with +4% tolerance on power consumption.	The process industry places emphasis on throughput with lower priority on power consumption. However, the user should identify the guarantee point at the time of purchase if performance tests are contemplated. This will avoid disputes while acceptance tests are in progress.
1.5.17 and 2.3.1.1.1; also 2.3.1.2	Maximum allowable working pressure	At least equal to relief valve setting, or at least 1.25 times the maximum discharge pressure (gauge) experienced during operation. Maximum pressure occurs when the machine	The manufacturer should be requested to state this, with no relationship to the actual service condition. This will be useful if future conditions should require more head. Heavier casing also

		operates at maximum continuous speed close to surge with anticipated combination of highest molecular weight, highest suction pressure, and lowest inlet temperature.	guarantees less susceptibility to changes due to piping loads and its effect on machine alignment. Observe adequacy for settling-out pressure.
2.1.1	Head and capacity characteristic curve	Rising characteristics up to the surge point; may be defined in percentages	Desirable from the point of view of anti-surge and general flow control since there is change in head for a change in the capacity over the entire operating range.
2.3.1.5	Axial split casing joint	Metal-to-metal joint	This is an important point to be remembered by maintenance organizations. A predefined sequence of tightening bolts, preferably with a hydraulic torque device, will avoid costly assembly errors in the future.
	Diaphragm cooling	Independent cooling passages	Precludes entry of cooling medium into compressor casing.
2.5.3.1	Raw material for the shaft	For 8" and above, the starting point shall be a forging. Although	Heat-treated forgings are the preferred raw material from the

		even below this limit it is preferred to use a forging, experienced manufacturers may be permitted to start with quality-controlled bar stock.	point of view of strength and stress-concentration factors.
2.5.10.6	Balancing	Use of welding as a means to balance an impeller is not permitted.	Welding can introduce flaws, in addition to difficulties in controlling the mass. Maintenance engineers must strictly observe this rule.
2.5.4.1	Balance Chamber Pressure	Provision is required	Found missing in many installations. Trending this pressure gives a good indication of casing internal leakage.
2.7.1.3	Inlet oil temperature	If it exceeds 49°C, special considerations are required.	In desert atmospheres and with fin fan coolers, oil header temperatures range in the vicinity of 55°C and bearing metal temperatures above 115°C (summer conditions). Consider a closed or thermosiphon water cooling system.

2.6.2.10	Separation margin	The damped unbalanced response analysis shall indicate that the machine will meet the following SM: - If the AF at a particular critical speed is less than 2.5, the response is considered critically damped and so no SM is required. - If the AF at a particular speed is 2.5 or greater and that critical speed is below the minimum speed, the SM (as a percentage of the minimum speed) shall not be less than the value from Equation below or the value of 16 whichever is less. $SM = 17\{1 - [1/(AF - 1.5)]\}$. - If the AF at a particular critical speed is equal to 2.5 or greater and that critical speed is above the maximum	These paragraphs represent guidelines to obtain an acceptable rotor design. Also, it calls for the verification of the calculated results on the test stand.
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		continuous speed, the SM (as a percentage of the maximum continuous speed) shall not be less than the below or the value of 26 whichever is less. $SM=10+17 \{1-[1/(AF-1.5)]\}$	
2.6.3	Shop verification of unbalanced response analysis	Outlines the importance of verification of the theoretical results with the ones actually obtained on the test stand.	The deviation in the results beyond permissible limits helps to form guidelines. It gives the designer more insight in correcting the assumptions and thus can improve overall prediction capability.
2.6.8.1 through 2.6.8.8	Balancing	Does not necessarily specify desirable high-speed balancing.	During the mechanical running test of the machine, assemblies with the balanced rotor, operating at its maximum continuous speed or at any other speed within the specified operating speed range, the peak-to-peak amplitude of the

			unfiltered vibration in any plane, measured on the shaft adjacent and relative to each radial bearing, shall not exceed the following value or 25 micrometer (1mil), whichever is less: In SI units: $A=25.4 (12000/N)^{0.5}$ where A= amplitude of unfiltered vibration, in micron (mil) true peak-to-peak, N= maximum continuous speed, in rpm. At any speed greater than the maximum continuous speed, and up to and including the trip speed of the driver, the vibration level shall not increase more than 12.7 micron (0.5mil) above the maximum value recorded at the maximum continuous speed.
2.2	Materials	Steel casing to be used as per guidelines clauses. Disallow materials susceptible to brittle	Review appropriate guidelines for material selection.

		fracture at ambient temperature. In case of H₂S (sour) environment, ferrous material selection must be limited to those having maximum yield strength of 90,000 psi and RC22 maximum hardness. Austenitic stainless steel should not be used in services likely to experience stress-corrosion cracking. For hydrogen service with partial pressure in excess of 100 psi or over 90 molal percent H₂, impeller material yield strength shall not exceed 120,000 psi and hardness RC34.	
3.1.4, 3.1.5, 3.1.7	Driver Sizing	110% of the maximum power required at any operating condition, inclusive of coupling and gear losses for motors and steam turbines. Determination to be made by mutual agreement	For steam turbines, consider future upgrade requirements. Are two-sided shaft extensions possible? Is space available for a helper turbine?

		for gas turbine drivers.	
3.2	Gear couplings		Lubricated gear couplings are not normally provided on new installations. Contoured diaphragm or flexible disc couplings are preferred but must have prior experience. On older machines with gear couplings, consider, replacement with contoured diaphragm couplings.
3.5.1.4	Provision of bypass for flushing	Applicable to bearings and seals	This aspect should be carefully reviewed. Flushing with minimum effort may be difficult unless suitable provisions are designed-in.
4.3.3	Impeller overspeed	At 115% of MCS for a minimum duration of one minute.	Check the impeller for deformation and dimensional variations. Are runaway situations possible in variable speed applications?

4.3.6	Mechanical running test	Important point to note: 1. Minimum degree of filtration 10 microns or better. 2. Test with contract items to include coupling, vibration transducers, seals, bearings 3. Observation and recording of several parameters at 10% speed increments up to MCS to include oil supply rate to every line, pressure, temperature, sour seal oil rate. 4. Run the machine at trip speed for 15 minutes, followed by a four-hour run at MCS. 5. Collection of vibration spectra at each operating point, also during start-up and coast-down. 6. Identification of lateral critical speeds, separation	A mechanical running test is mandatory both for the main rotor and spare rotor. It assists in determining mechanical losses. Try to use lube-oil grade equivalent to type used at installation site and maintain highest permissible lube-oil inlet temperature during shop testing.
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		margins, and any testing to be done in the context of unbalance response analysis.	
4.3.7	Leakage test	After completion of mechanical running test, casing along with seal will be pressurized to maximum sealing (or seal design pressure). Also, casing shall be pressurized to rated discharge pressure (with or without end seals).	Will ensure integrity of the casing joint. Inert gas (N ₂) is recommended. Helium gas is recommended for low molecular weight gases.
4.3.8	Optional Tests	Various test ranging from performance test (4.3.8.1) to dismantling and reassembly (4.3.8.8). Inspection to be defined under this optional category. Full-pressure/full-load/full-speed test (4.3.8.6)	All tests should be carried out at the manufacturer's facility in order to minimize site problems. This is an opportunity for owner's representative to become familiar with equipment. Beneficial a high-pressure applications in which seals can act as additional bearings and thus can affect the critical speed.
4.4.3.10	Preparation for shipment	Spare rotor	Preserved with rust-preventive

			coating and stored vertically to avoid bowing. Preferably located in humidity-controlled location.

Thanks To: Late Heinz P. Bloch, Book: Compressors and Modern Process Applications