

API 671 — COUPLINGS WHAT IS THE IMPACT ON THE USER?

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O.E.M.'s main objective was to see that the coupling did not detract from his equipment. The user's focus on the objective of operating trouble free for many years was somehow lost.

The API 671 standard, in deriving its input from users as well as O.E.M.'s, provides an organized, more universal document to use as a basis for purchase. As in all API standards, API 671 is basically user oriented and carries that tone even when used for purchase by an O.E.M. The coupling manufacturer now sees the specification in a more unified form and must only interpret variations as opposed to rationalizing many specification languages and formats. The user benefits from this because he can profit from a total industry effort, rather than feeling as if he were all alone in his specification. This concentrated effort should help bring a sharper focus on those areas needing concentration.

GENERAL DISCUSSION

A discussion of various parts of the API 671 standard may illustrate some of the areas where a unified approach should aid in the overall understanding of what's needed and how the need is met. Section 1 deals with several areas that are helpful to the user. The scope sets the stage for what is to follow, but clearly establishes the intent of the user, which is to have the couplings operate problem-free for extended periods of time in critical service. It gives a nominal time of three years, a value used for critical service of special purpose equipment in other API Standards. As in all standards, this value is used as a starting point, a point from which to depart. However, in stating this period regardless of the final target, it should be clear what was intended in saying continuous service for an extended period. The use of a value like three years gives a clear indication that the period is longer than 0.3 years and probably less than 30 years.

Another very useful feature of Section 1 is the definition of terms. Most communications are considerably enhanced if the communicators are working from a common definition of terms, or conversely, how badly things foul up when terms with inconsistent definitions are used as a basis to communicate.

BASIC DESIGN

The "general" paragraph of Section 2 again is useful to the user because it conveys an intent. Unfortunately, there are many arguments concerning rating criteria. Regardless of the actual value, it should be clear from the values stated that the user is trying to pass on to the coupling vendor that if a basic driven machine rating is stated in the communication, this is not the final story. In this manner, the user is guided in how to tell the vendor that in actual service the equipment is subject to more than "single parameter", steady ideal conditions. Thoma [10] presented arguments and data for mechanical train design which experience shows is more realistic. Figure 1 is a graphical summary of his presentation. When all the margins

INTRODUCTION

Flexible couplings are a very small part of a turbomachinery train in terms of the total capital investment. In terms of its contribution to reliability, the flexible coupling takes on a more significant role. Unfortunately, the past history has been that this contribution was more negative than positive. Put more simply — when the flexible coupling does its job, it goes unnoticed. However, when the coupling malfunctions, it draws the spotlight very quickly. The answer is not just simply to spend more money on the coupling, although an increase in cost is an unfortunate by-product as the problems of achieving reliability are attacked.

UNIFIED DESIGN SPECIFICATION

The two areas on which attention should be focused are the areas of application and design. The subject of application has been covered in many good papers, including the past Turbomachinery Symposia, and is not the subject here [1, 2, 3, 4, 5, 6, 7, 8]. This paper addresses the area of design. It does so not directly as a coupling designer, but as a user trying to convey to the coupling designer and manufacturer his requirements and needs by way of a specification.

Before the API 671 Standard, Special-Purpose Couplings for Refinery Services, [9] was published, many coupling users were attempting to use their individual specifications. In most instances, there were many different ways to say the same thing. There were divergent points of view because the user relied heavily on the Original Equipment Manufacturer (O.E.M.) of the driven train to handle the bulk of the chore. However, as is often the case, the user had valid input which often did not reach the coupling manufacturer because the

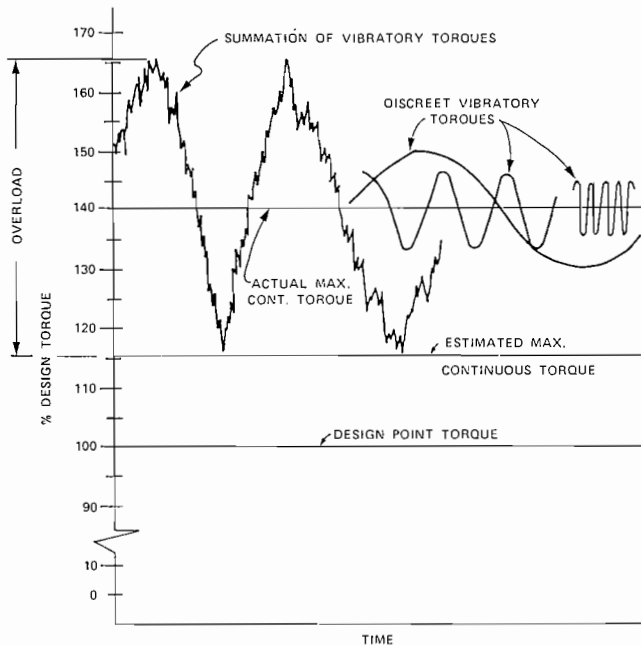


FIGURE 1. Typical Mechanical Drive System Torque Components.

recommended by API 671 [11], API 612 [12], API 613 [13], or other appropriate standards are added to the safety factor built into drives to meet minimum and unexpected conditions, plus the influence of various non-steady load factors (such as non-resonant torsional responses), a design torque value larger than the normal 100% point for the driven equipment is in order. While an absolute value is subject to argument, the Standard incorporates what a combination of users felt was a reasonable value, realizing that a small fraction above or below the recommended value is not necessarily fatal. In fact, for unusual non-steady applications where unusual transients are expected, these should be communicated and the Standard applies a safety margin to allow for a possible variation in the estimate. The value of 175 and 1.15 are spelled out for all parties to be aware of in case a different value is desired. Such may be the case where operating parameters are tightly controlled and all variations are known, or in cases where overhung weight criteria call for a trade-off between torque rating and weight for the improvement of lateral stability. As in all cases, local circumstances must dictate final values, but in the majority of situations use of the values as stated will provide a coupling rating consistent with the connected equipment capability.

In the balance of the Basic Design section, detailed design aspects of the coupling and the coupling attachment are covered, providing a basis for the user to employ when evaluating the coupling being considered for the given application. The user may simply use the Standard as a checklist and evaluate from experience, or going further, the inexperienced user can gain tutorial benefits from having minimum values presented as a design criteria to help him understand a specific proposal. Unless a user has spent a great deal of time familiarizing himself with couplings, the particulars of attachment details, methods of maintaining concentricity, tolerance, bolting, and hardness levels present a confusing conglomeration of information. Using API 671 insures that the proposed vendor has bid to a uniform specification and when exceptions are taken, base values from which to judge the variations are available.

BALANCE

One area not mentioned at this point in the discussion is the subject of balance. Many users, both with large and small companies, are usually confused when the subject of balance is mentioned. In the not so distant past balancing was practiced as a "black art." With modern equipment and computers, it's now still somewhat of an art, but a computer-assisted art. However, the human must still bear the responsibility of the results. The balance specification is a part of the Basic Design section of the Standard. To help the user, API 671 offers three balance procedures. The user, or the user together with the O.E.M., can select the procedure most ideally suited to the job. A balance tolerance is suggested for each procedure. Also, there is some tutorial information supplied to help the user. When done, the user, who was confused by balance, may still be confused, but can rest assured that his specification will provide the basis for a proper balance of his coupling. Briefly, the three methods are: 1) component balance, 2) component balance with an assembly check but no correction allowed, or 3) component plus assembly balance. Method 2 is somewhat a compromise between methods 1 and 3. The decision is more or less a trade-off between maintenance and rotor dynamics. In method 1, component balance allows for maximum freedom for the interchange of parts of the coupling for maintenance, but the balance level of the assembly is an unknown quantity. If the sensitivity of the rotor with the attached coupling is not very high, this method is the one to use. Method 2 adds the requirement to check the balance level of the assembly, but no correction to the assembly is allowed. The tolerance here is higher for the assembly than permitted by method 3. Only when the tolerance stated is exceeded must a correction be made, and then only by diagnosing which component caused the problem and correcting it rather than the assembly. When the rotor dynamics indicates the potential of a sensitive rotor, method 3, which calls for an assembly balance after component balance to the same tolerance as components, will provide the highest degree of balance to an assembled coupling.

As stated before, the trade-off is the loss of parts interchangeability without having to rebalance the assembly. The Standard provides a caution flag in the Potential Unbalance paragraph, stating that balance is influenced by a number of factors. One factor in particular that the coupling manufacturer cannot control is the eccentricity of the final shaft to which the coupling will be mounted. The shaft can have an eccentricity different from the eccentricity of the balance mandrel used for an assembly balance. By marking "high spots" this effect may be minimized, but probably cannot be totally eliminated. It may, in some critical cases, be necessary to trim balance in a shop "string" test or to perform a field balance. Should field balance be expected to later be a possibility, the trim balance hole option should be specified.

MATERIALS OF CONSTRUCTION

The materials of construction for couplings cover a wide range of materials. Caution flags are given regarding environment and materials. The wise user will heed the advice that any environmental factors affecting material choice must be communicated to the vendor.

QUALITY

The user is provided with some minimum assistance toward specifying quality. Most statements are really common sense items as to where and where not to etch or stamp parts. Unfortunately, however, even this type of procedure needs, in some cases, to be written.

Probably the strongest specification for the user is the requirement that the repair of defects in the torque transmitting path must not be performed without the purchaser's approval. The user should be made aware of any repairs of this nature, which the approval requirement provides.

INSPECTION AND TESTING

The area of inspection and testing records needs to be addressed. Unless a user is quite experienced, it would probably not occur to him to request that certain quality records be maintained for a period of time. In API 671, the specified period is five years minimum. Many manufacturers do this as a matter of course; this is a factor that should not be assumed. While no one likes to think about potential problems, it is quite important that, should a failure occur which involves the coupling, data on materials, heat treats, and such be available as an aid in analyzing the failure.

Other areas of inspection are specified using ASTM and ASME procedures and criteria to provide the user with a specification for the inspection method with which he may be familiar or which may be readily reviewed prior to inspection. When only procedures unique to each vendor are available, the user has the feeling of exclusion. It is easier to communicate when recognized standards are directly applied or, if this is not possible, at least have the vendor show a comparison of the "in-house" to the specified procedures, using the specified standards as a basis of reference.

PREPARATION FOR SHIPMENT AND SPECIAL TOOLS

A minimum shipment preparation is specified. Many large users may have their own company standards for this. However, the user has a specification available for use on a stand alone basis, if desired. Users without their own standards will find this helpful.

The same applies to special tools. For an inexperienced user, the "Special Tools" section brings the subject to his attention and assures him that these items are to be furnished to him, rather than find out at installation time that special tools are needed and are not available at the job site.

VENDOR'S DATA

The final section gives the user a list of items to expect from the vendor which will be required during engineering and later during installation. API 671 is relatively complete in this aspect and saves the user the problem of having to remember all documents. Also by being an industry standard, it gives the vendor the opportunity to organize his documentation to fit the standard and not have each user make a completely unique request.

DATA SHEETS

The data sheet is a very useful tool to the user. It acts as a summary of the various engineering details which will be exchanged. It prompts the user to provide data that is necessary for the vendor to do a proper selection and design. It provides for vendor feedback on the many details covered in API 671. To assist in filling in the blanks, reference is made on the data sheets to a reference paragraph in the API 671 document to help define the particular piece of information called for in the blank. This should provide for a more uniform interpretation of the data sheet information.

APPENDIX

For the user there have been provided in the Standard several appendices. The materials list is provided as a guide and again would fall into the minimum category. It is not intended to be exclusive, so that a vendor's offer of a material superior to those listed for a given condition certainly would not be excluded. Should the user choose, Appendix C is provided for the specification of coupling guards. Many times this rather important subject is just assumed with the user being rudely surprised at what he has been furnished when the final installation is reviewed. Appendix D is made available to cover a rather special coupling that becomes more important with certain installations such as large motors in the refining, chemical and petrochemical plants. Large synchronous motors, particularly salient pole machines, starting on internal windings, exhibit a pulsating torque characteristic [14, 15, 16]. In some cases the damping provided by a torsional resilient coupling is needed. When such as described or any other case where the torsionally resilient coupling is called for, the user has a minimum specification available in Appendix D.

Appendix E & F are tutorial in nature to guide a user in the selection and measurement of tapers. Appendix E provides a comparison of three common tapers and the pros and cons of these values. Appendix F gives some guidelines on taper gauges, an optional special tool which is recommended for consideration by API 671.

CONCLUSION

With the development and subsequent publication of API 671, the user can approach the subject of coupling specification with more confidence than was possible prior to the Standard. The Standard offers the user the benefit of the combined input of a large number of users by way of the API Mechanical Equipment Subcommittee. The user should have the confidence in applying this Standard that not only can he benefit from the input from the users, but also benefit from a more complete bid from the vendor who now can improve bid quality due to a uniform user specification.

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