



Magnetic Standards in Manufacturing

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Our World Touches Your World Every Day...

Agenda

- Why have standards?
- Standards Organizations
- Types of Standards
- Magnetic Material Standards
- ASTM Standards



• Today we'll be covering these subjects and I will attempt to provide you with an appreciation for the value of standards and specifically what is happening in the area of magnetics standards.

Why have standards?

- Standards form the basis for discussion regarding
 - Material properties
 - Purchase agreements for raw materials, sub-assemblies and finished product
 - Acceptance or rejection of product by broadly accepted, proven test methods
 - Meaningful comparison of competitive materials or designs
- Standards are almost always in the form of a formal document, recognized by standards organizations, government and industry associations
 - This differentiates it from custom, convention, company product information and internal corporate standards



Other Benefits of Standards

- Provide rationale for test or specification
- Education regarding material and tests
- Support information such as calculations
- Recommendations for applying the test or specification
- Caveats & pitfalls of the test or specification
- References



- In addition to presenting details of the test method, a good standard also provides the reason for performing the test or for using this particular test method.
- It can also explain issues associated with the test such as advantages / disadvantages, accuracy / inaccuracy and the underlying science of the method.
- Participating in the writing of standards is a wonderful learning opportunity in association with knowledgeable peers in the industry.

Standards Organizations

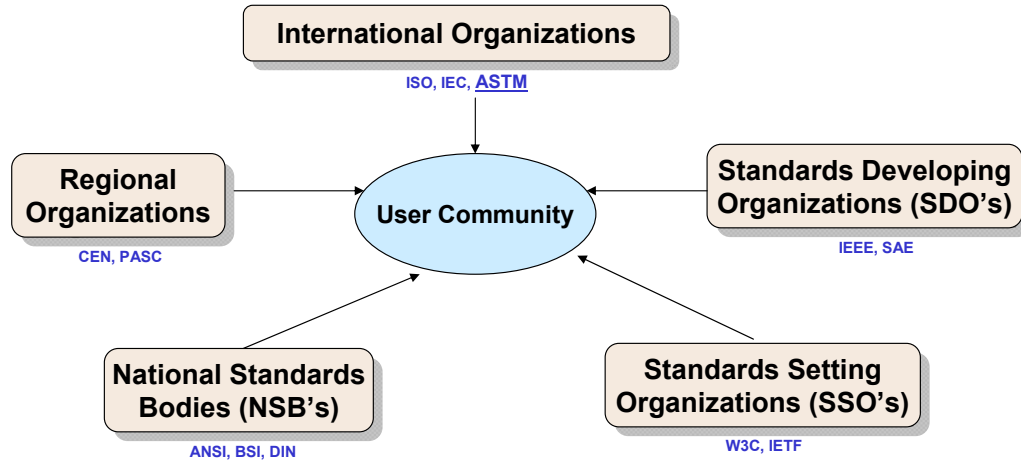
with examples...

- International Standards Organizations (broad-based)
 - ISO, ASTM, WSC (World Standards Cooperation)
- Regional Standards Organizations
 - European Committee for Standardization (CEN), European Committee for Electrotechnical Standardization (CENELEC), Pacific Area Standards Congress (PASC)
- National Standards Bodies (NSB's)
 - ANSI, BSI, DIN, JISC
- Standards Developing Organizations (SDO's)
 - IEEE, IEC, SAE, API, ITU
- Standard Setting Organizations (SSO's)
 - W3C, IETF



- There are dozens of standards organizations in the world.
- International standards bodies as shown here are broad-based – that is, covering many industries or disciplines. Examples are ISO and ASTM.
- Many standards organizations are national, such as NIST or ANSI, or regional, such as CEN in Europe.
- Some are industry-specific, and may be national, regional or international with respect to geographic participation. Examples are IEEE, IEC SAE, etc.
- A few standards organizations were developed to serve a rapidly evolving situation. W3C, the World Wide Web Consortium, formulated the rules for programming and presenting internet delivered information. It evolved into a well-recognized organization which continued the role of coordinating web standards.

Standards Organizations



- The user community can benefit from standards relevant to:
 - o The specific geographic location
 - o The test or specification for a product or measurement specific to their industry
 - o That which is more generally recognized within their specific industry.
- Most of the standards organizations cooperate with each other, but retain individual property control of standards.

Types of Standards

- Definitions
- Material specifications
- Test methods (measurement of raw material, component or sub-assembly)
- Test methods (measurement of finished product)
- Operating Procedures



- These are the typical sort of standards.
- We'll see how this list compares with ASTM and IEC committees a bit later.

Magnetic Standards in the USA

For the past 40+ years, there have been three active organizations...



- MMPA, IMA (~1962 to 2006)
- IEC (1906 to present)
- ASTM (1898 to present)



- The MMPA, the Magnetic Material Producer's Association, was formed by a group of US magnet manufacturers in the early 1960's. It changed into the IMA (International Magnetics Association) in 2003. It was disbanded in 2006 with members moving to the Transformer Association (soft magnetics) or the SMMA (permanent magnets).
- The IEC came into being on 26-27 June 1906 in London, UK.
- ASTM is the oldest of the three having started in 1898.

MMPA Standards and Guides

- Soft Ferrites: A User's Guide, 1998
- Testing and Measurement of Permanent Magnets, 1975
- Permanent Magnet Guidelines, 1988
- Standard Specifications for Permanent Magnet Materials, 2000

The MMPA changed its name to IMA (International Magnetics Association) in 2001 and then became inactive in 2006. The website is still present and some documents can still be viewed or downloaded (www.intl-magnetics.org)



- With the dissolution of the IMA in 2006, the Soft Ferrite document ownership continues with those members who joined the Transformer Association.
- The permanent magnet documents transferred to the Permanent Magnet Division (PMD) within the SMMA. (Effective June 2010, the SMMA merged with the MCA to form the MCMA, the Motion Control and Motor Association).
- The Permanent Magnet Guidelines and Standard Specifications documents are available for download from the SMMA website. These documents have not yet undergone review by the PMD and are presented “as-is.”
- An older document, Testing and measurement..., has useful information but is dated and would benefit from revision. The PMD is currently considering the value in updating this document.

IEC Magnetics Activities

- WG1
 - Classification, composition and properties of magnetic materials
- Joint WG: TC68 WG1 & ISO TC17 WG16
 - Specifications of magnetic steels
- WG2
 - Measuring methods
- Maintenance Team 3: jointly with TC51
 - Terminology – maintenance
- WG4
 - Magnetic alloys of iron-nickel, iron-cobalt, iron-aluminum, and iron-aluminum-silicon
- WG5
 - Hard magnetic alloys and ceramic materials



- Magnetic material specification and test methods are under the purview of Technical Committee 68 (TC68).
- TC68 has the listed functional Work Groups (WG1 through WG5).
- The United States national committee (USNC), which is administratively associated with ANSI, provides USA input to the IEC.
- The USNC's membership comes mostly from representatives of the several electrical and electronic engineering and trade associations. Other participants in the USNC are technical advisors to the USNC on the affairs of the several IEC technical committees which comprise the technical work of the IEC.
- Magnetic specifications in IEC are represented for the USA by members of ASTM committee A06 under the auspices of ANSI. The ASTM representatives are currently Richard Lyke, Reinhold Strnat, Scott Masteller and Steve Constantinides.

IEC Magnetics Standards (23)

IEC 60404-1,	Ed.2: 2000-08	Magnetic materials. Part 1: Classification.
IEC 60404-1-1,	Ed.1: 2004-04	Magnetic materials - Part 1-1: Classification - Surface insulations of electrical steel sheet, strip and laminations
IEC 60404-2,	Ed. 3:1 2008-6	Magnetic materials. Part 2: Methods of measurement of the magnetic properties of electrical steel sheet and strip by means of an Epstein fr
IEC 60404-3,	Ed. 2.2 2010-04	Magnetic materials. Part 3: Methods of measurement of the magnetic properties of magnetic sheet and strip by means of a single sheet test
IEC 60404-4,	Ed. 2.2: 2008-11	Magnetic materials. Part 4: Methods of measurement of the d.c. magnetic properties of iron and steel.
IEC 60404-5,	Ed 2: 2007-02	Magnetic materials. Part 5: Permanent magnet (magnetically hard) materials - Methods of measurement of magnetic properties.
IEC 60404-6,	Ed. 2: 2003-06	Magnetic materials. Part 6: Methods of measurement of the magnetic properties of isotropic nickel-iron soft magnetic alloys, types E1, E3
IEC 60404-7,	Ed. 1: 1982-01	Magnetic materials. Part 7: Methods of measurement of the coercivity of magnetic materials in an open magnetic circuit.
IEC 60404-8-1,	Ed. 2.1: 2004-07	Magnetic materials. Part 8: Specifications for individual materials. Section One - Standard specifications for magnetically hard materials.
IEC 60404-8-3,	Ed. 3: 2005-08	Magnetic materials. Part 8-3: Specifications for individual materials - Cold-rolled electrical non-alloyed and alloyed steel sheet and strip d
IEC 60404-8-4,	Ed. 2: 1998-05	Magnetic materials. Part 8-4: Specifications for individual materials - Cold-rolled non-oriented electrical steel sheet and rip delivered in th
IEC 60404-8-5,	Ed. 1: 1989-05	Magnetic materials. Part 8: Specifications for individual materials. Section Five - Specification for steel sheet and strip with specified mee
IEC 60404-8-6,	Ed. 2.1:2007-06	Magnetic materials. Part 8-6: Specifications for individual materials - Soft magnetic metallic materials.
IEC 60404-8-7,	Ed. 3: 2008-05	Magnetic materials. Part 8-7: Specifications for individual materials - Cold-rolled grain-oriented electrical steel sheet and strip delivered in
IEC 60404-8-8,	Ed. 1:1991-09	Magnetic materials. Part 8: Specifications for individual materials. Section 8 - Specification for thin magnetic steel strip for use at medium
IEC 60404-8-9,	Ed. 1:1994-08	Magnetic materials. Part 8: Specifications for individual materials. Section 9: Standard specification for sintered soft magnetic materials.
IEC 60404-8-10,	Ed. 2: 2009-5	Magnetic materials. Part 8: Specifications for individual materials - Section 10: Specification for magnetic materials (iron and steel) for us
IEC 60404-9,	Ed. 1: 1987-09	Magnetic materials. Part 9: Methods of determination of the geometrical characteristics of magnetic steel sheet and strip.
IEC 60404-10,	Ed. 1: 1988-08	Magnetic materials. Part 10: Methods of measurement of magnetic properties of magnetic steel sheet and strip at medium frequencies.
IEC 60404-11,	Ed 1.1: 1999-01	Magnetic materials. Part 11: Method of test for the determination of surface insulation resistance of magnetic sheet and strip.
IEC 60404-12,	Ed. 1: 1992-11	Magnetic materials. Part 12: Guide to methods of assessment of temperature capability of interlaminar insulation coatings.
IEC 60404-13	Ed. 1: 1995-09	Magnetic materials - Part 13: Methods of measurement of density, resistivity and stacking factor of electrical steel sheet and strip.
IEC 60404-14	Ed. 1: 2002-06	Magnetic materials - Part 14: Methods of measurement of the magnetic dipole moment of a ferromagnetic material specimen by the withdr



- This is a listing of the current IEC specifications related to magnetics. There are 23 total.
- They are available for purchase directly from IEC or from the ANSI web-store (<http://webstore.ansi.org>)
- Each of the specifications may have one or more amendments.

ASTM Magnetics Committees

- A06 – Main
 - R. Strnat, Chairman, 43 participants
- A06.01 – **Test Methods**
 - R. Strnat, Sub Chairman, 26 participants
- A06.02 – **Material Specifications**
 - M. Masteller, Sub Chairman, 26 participants
- A06.92 – **Terminology and Definitions**
 - S. Constantinides, Sub Chairman, 13 participants
- A06.93 – **Precision and Bias**
 - T. Thomas, Sub Chairman, 11 participants



- ASTM committees were formed to address each of the normal standards subjects
- Operating Procedures are covered as necessary in the Test Methods standards.
- An additional committee, Precision and Bias, was formed to deal with numerical quantification issues, primarily associated with Testing.

ASTM Magnetic Standards

50 approved standards and two at the balloting stage

Support Documents A34: Standard Practice for Sampling and Procurement Testing of Magnetic Materials
 A340: Standard Terminology of Symbols and Definitions Relating to Magnetic Testing
 A342: Standard Test Methods for Permeability of Feebly Magnetic Materials
 A664: Standard Practice for Identification of Electrical Steel

Type of Product	Material Specification	Test Method
Magnetically Soft	A345, A677, A683, A726, A753, A801, A811, A838, A839, A840, A848, A867, A876, A901, A904, A1009	DC A341, A773, A894
		AC A343, A348, A598, A697, A772, A804, A889, A912, A927, A932, A1013, A1036
Semi-hard	--	DC A596
		AC --
Magnetically Hard	A1054	DC A977
		AC --
Resistivity, Resistance	--	-- A712, A717, A937
Miscellaneous	A976	-- A342, A698, A719, A720, A721, A893, A900, A971

Current focus area – specs for Alnico, SmCo, Neo, and others



- There are currently 50 active standards with more in the writing and balloting phases.
- ASTM standards must be reviewed at least every five years for accuracy and continued relevance.

How Standards are Evolving

- Newer test techniques
- Computerized control
- Material-specific testing requirements
- Improvements in reproducibility, precision and accuracy



EXAMPLE
Hybrid and electric traction motors are requiring new devices, new test methods and new specifications.



- There are new measurement techniques being developed.
- For example, a proposed method to measure very high intrinsic coercivity magnetic materials is PFM, Pulse Field Magnetometry. After the technique has been proven fully functional, a standard will be prepared.
- in a second example, an instrument for measuring feebly magnetic materials developed by Föerster Instruments resulted in standard A342.

Participation in ASTM

- Soft and permanent magnetic materials
- New test methods
- Semi-annual meetings
- Web-based conference calls
- Join ASTM, contact ASTM directly or one of the A06 Committee members
- Learn more at:
 - www.astm.org/COMMITTEE/A06.htm



- The technical and manufacturing community benefit from the work of standards organizations.
- These organizations benefit from the active participation of the manufacturers and users.
- We at ASTM would like to encourage your participation.



References

1. International Standards Applied to Magnetic Alloys and Steels, Hugh J. Stanbury, IEEE Transactions on Magnetics, Vol. 46, No. 2, February 2010
2. International Standards for Magnetic Materials and Components, John L. Dalke, IEEE Transaction on Magnetics, September 1971
3. Permanent Magnets, Reinhold, Strnat, ASTM Standardization News, October 2006, www.astm.org/SNEWS/OCTOBER_2006/strnat_oct06.html
4. ASTM website, www.astm.org
5. IEC website, www.iec.ch

