# Samarium Cobalt Magnet

## Introduction of Samarium Cobalt Magnet

Samarium Cobalt Magnet appeared in the 1960s and are the first and second generation of rare-earth permanent magnets discovered, SmCo5 and Sm2Co17 structures of rare-earth cobalt permanent magnets respectively. With high magnetic energy product and reliable coercivity, they have superior magnetic performance compared with the earlier discovered Alnico magnet and ferrite magnet, which made SmCo magnet materials much more popular.

Samarium cobalt magnet is a kind of permanent magnet made of samarium, cobalt and other elements with melting, crushing, pressing and sintering. Samarium cobalt magnets are known for their high magnetic strength and good temperature stability, it is usually slightly weaker than NdFeB magnets at room temperature, but at extreme temperatures, when NdFeB magnets fail to work, it can still provide very powerful magnetic performance. Since SmCo magnets are highly resistant to corrosion and oxidation, coatings are generally not required.

SmCo magnets are mainly used in various industries such as aerospace, national defense, microwave devices, medical equipment, permanent magnet motors, etc.
Its main features are 1. Very good coercive force performance 2. Good temperature stability
3. Durability Corrosion and oxidation resistance

SmCo5 is the first generation of rare-earth permanent magnets. Compared with the second generation Sm2Co17, SmCo5 has a higher proportion of cobalt, so the cost is relatively higher, but the magnetic performance is worse, so in many applications, it has been replaced by Sm2Co17, and even the third generation of rare-earth permanent magnets NdFeB. However, SmCo5 is still used in some applications because of its excellent temperature performance and less brittle compared to Sm2Co17.

Sm2Co17 is the second generation of rare-earth permanent magnets, compared to Alnico and ferrite, the magnetic performance is much better, so after the discovery of rare-earth permanent magnets, Alnico and ferrite are replaced by rare-earth permanent magnets in many industrial applications. Sm2Co17 is the material with high Curie temperature and working temperature among rare earth permanent magnets. Although it is surpassed by NdFeB, the third generation of rare earth permanent magnets, in terms of magnetic performance, and replaced by NdFeB in some applications, Sm2Co17 is the best choice among high performance permanent magnet materials with high temperature resistance. Sm2Co17 has a very important role in magnetic accessories such as aircraft motors, generators, transmissions, sensors, function converters, magnetic bearings, microwave function tubes, etc., which need to work reliably at high temperatures.

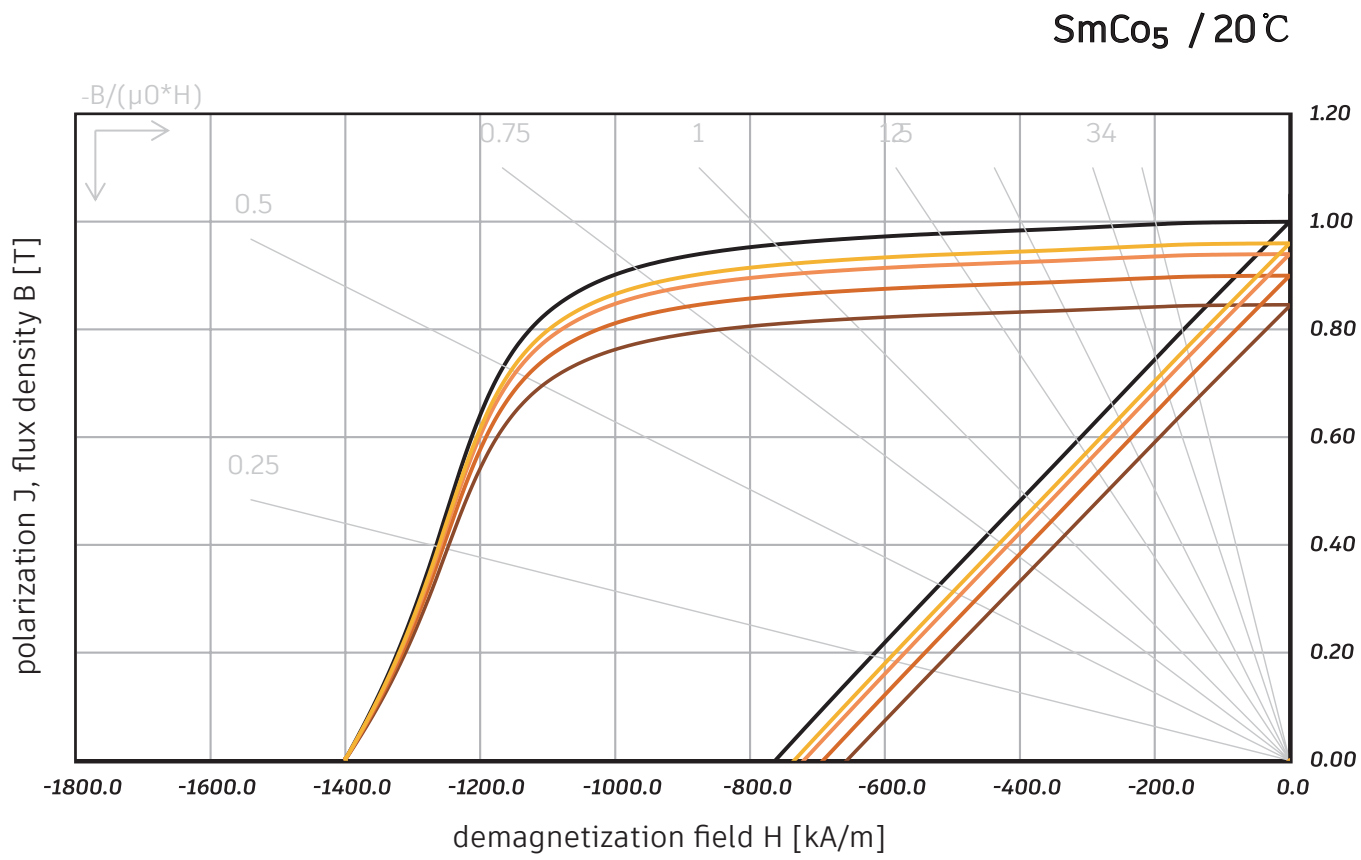
# Magnetic Properties of SmCo Magnets

| Item | Grade | BR | | HCB | | HCJ | | (BH) MAX | | Working Temperature | Density |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T | KGS | KA/M | KOE | KA/M | KOE | KJ/M3 | MGOE | °C | G/CM3 |
| SM1CO5 | HMS-16 | 0.77-0.85 | 7.7-8.5 | 613-660 | 7.7-8.3 | 1194-1400 | 15.0-17.6 | 110-127 | 14-16 | 250 | 8.3 |
| | HMS-18 | 0.81-0.90 | 8.1-9.0 | 637-700 | 8.0-8.8 | 1194-1400 | 15.0-17.6 | 127-143 | 16-18 | 250 | 8.3 |
| | HMS-20 | 0.85-0.94 | 8.5-9.4 | 637-725 | 8.0-9.1 | 1194-1400 | 15.0-17.6 | 150-167 | 19-20 | 250 | 8.3 |
| | HMS-22 | 0.89-0.96 | 8.9-9.6 | 661-748 | 8.3-9.4 | 1194-1400 | 15.0-17.6 | 160-175 | 20-22 | 250 | 8.3 |
| | HMS-24 | 0.96-1.00 | 9.6-10.0 | 730-770 | 9.2-9.7 | 1194-1400 | 15.0-17.6 | 175-190 | 22-24 | 250 | 8.3 |
| | HMS-16S | 0.77-0.84 | 7.7-8.4 | 613-660 | 7.7-8.3 | 1592-1650 | 20.0-20.7 | 118-135 | 15-17 | 250 | 8.3 |
| | HMS-18S | 0.81-0.89 | 8.1-8.9 | 637-700 | 8.0-8.8 | 1592-1650 | 20.0-20.7 | 135-151 | 17-19 | 250 | 8.3 |
| | HMS-20S | 0.85-0.93 | 8.5-9.3 | 637-732 | 8.0-9.2 | 1592-1650 | 20.0-20.7 | 150-167 | 19-21 | 250 | 8.3 |
| | HMS-22S | 0.89-0.96 | 8.9-9.6 | 661-756 | 8.3-9.5 | 1592-1650 | 20.0-20.7 | 167-183 | 21-23 | 250 | 8.3 |
| | HMS-24S | 0.96-1.00 | 9.6-10.0 | 740-788 | 9.3-9.9 | 1830-1900 | 23.0-23.8 | 183-199 | 23-25 | 250 | 8.3 |
| SM2CO17 | HMSG-22 | 0.90-0.97 | 9.0-9.7 | 644-740 | 8.0-9.3 | 1194-1400 | 15.0-17.6 | 159-183 | 20-23 | 300 | 8.4 |
| | HMSG-24 | 0.92-1.02 | 9.2-1.02 | 661-764 | 8.3-9.6 | 1194-1400 | 15.0-17.6 | 175-191 | 22-24 | 300 | 8.4 |
| | HMSG-26 | 1.00-1.05 | 10.0-10.5 | 677-796 | 8.5-10.0 | 1194-1400 | 15.0-17.6 | 191-207 | 24-26 | 300 | 8.4 |
| | HMSG-28 | 1.03-1.08 | 10.3-10.8 | 677-812 | 8.5-10.2 | 1194-1400 | 15.0-17.6 | 207-220 | 26-28 | 300 | 8.4 |
| | HMSG-30 | 1.07-1.10 | 10.7-11.0 | 700-828 | 8.8-10.4 | 1194-1400 | 15.0-17.6 | 220-240 | 28-30 | 300 | 8.4 |
| | HMSG-32 | 1.09-1.13 | 10.9-11.3 | 755-850 | 9.5-10.7 | 1194-1400 | 15.0-17.6 | 230-255 | 29-32 | 300 | 8.4 |
| | HMSG-35 | 1.16-1.18 | 11.6-11.8 | 868-888 | 10.9-11.2 | 1433-1450 | 18.0-18.2 | 255-267 | 32-34 | 300 | 8.4 |
| | HMSG-24H | 0.92-1.02 | 9.2-1.02 | 661-764 | 8.3-9.6 | 1990-2000 | 25.0-25.1 | 175-191 | 22-24 | 350 | 8.4 |
| | HMSG-26H | 1.00-1.05 | 10.0-10.5 | 677-796 | 8.5-10.0 | 1990-2000 | 25.0-25.1 | 191-207 | 24-26 | 350 | 8.4 |
| | HMSG-28H | 1.03-1.08 | 10.3-10.8 | 677-812 | 8.5-10.2 | 1990-2000 | 25.0-25.1 | 207-220 | 26-28 | 350 | 8.4 |
| | HMSG-30H | 1.07-1.10 | 10.7-11.0 | 700-828 | 8.8-10.4 | 1990-2000 | 25.0-25.1 | 220-240 | 28-30 | 350 | 8.4 |
| | HMSG-32H | 1.09-1.13 | 10.9-11.3 | 755-858 | 9.5-10.8 | 1990-2000 | 25.0-25.1 | 230-255 | 29-32 | 350 | 8.4 |
| | HMSG-33H | 1.12-1.16 | 11.2-11.6 | 845-890 | 10.6-11.2 | 1990-2000 | 25.0-25.1 | 240-260 | 30-33 | 350 | 8.4 |
| | HMSG-26M | 1.02-1.05 | 10.2-10.5 | 676-780 | 8.5-9.8 | 995-1100 | 12.0-13.8 | 191-207 | 24-26 | 300 | 8.4 |
| | HMSG-28M | 1.03-1.08 | 10.3-10.8 | 676-796 | 8.5-10.0 | 995-1100 | 12.0-13.8 | 207-220 | 26-28 | 300 | 8.4 |
| | HMSG-30M | 1.08-1.10 | 10.8-11.0 | 676-835 | 8.5-10.5 | 995-1100 | 12.0-13.8 | 220-240 | 28-30 | 300 | 8.4 |
| | HMSG-32M | 1.10-1.13 | 11.0-11.3 | 676-852 | 8.5-10.7 | 995-1100 | 12.0-13.8 | 230-255 | 29-32 | 300 | 8.4 |
| | HMSG-24L | 0.95-1.02 | 9.5-10.2 | 541-716 | 6.8-9.0 | 636-830 | 8.0-10.4 | 175-191 | 22-24 | 250 | 8.4 |
| | HMSG-26L | 1.02-1.05 | 10.2-10.5 | 541-748 | 6.8-9.4 | 636-850 | 8.0-10.6 | 191-207 | 24-26 | 250 | 8.4 |
| | HMSG-28L | 1.03-1.08 | 10.3-10.8 | 541-764 | 6.8-9.6 | 636-880 | 8.0-11.1 | 207-220 | 26-28 | 250 | 8.4 |
| | HMSG-30L | 1.08-1.15 | 10.8-11.5 | 541-796 | 6.8-10.0 | 636-900 | 8.0-11.3 | 220-240 | 28-30 | 250 | 8.4 |
| | HMSG-32L | 1.10-1.15 | 11.0-11.5 | 541-812 | 6.8-10.2 | 636-950 | 8.0-11.9 | 230-255 | 29-32 | 250 | 8.4 |

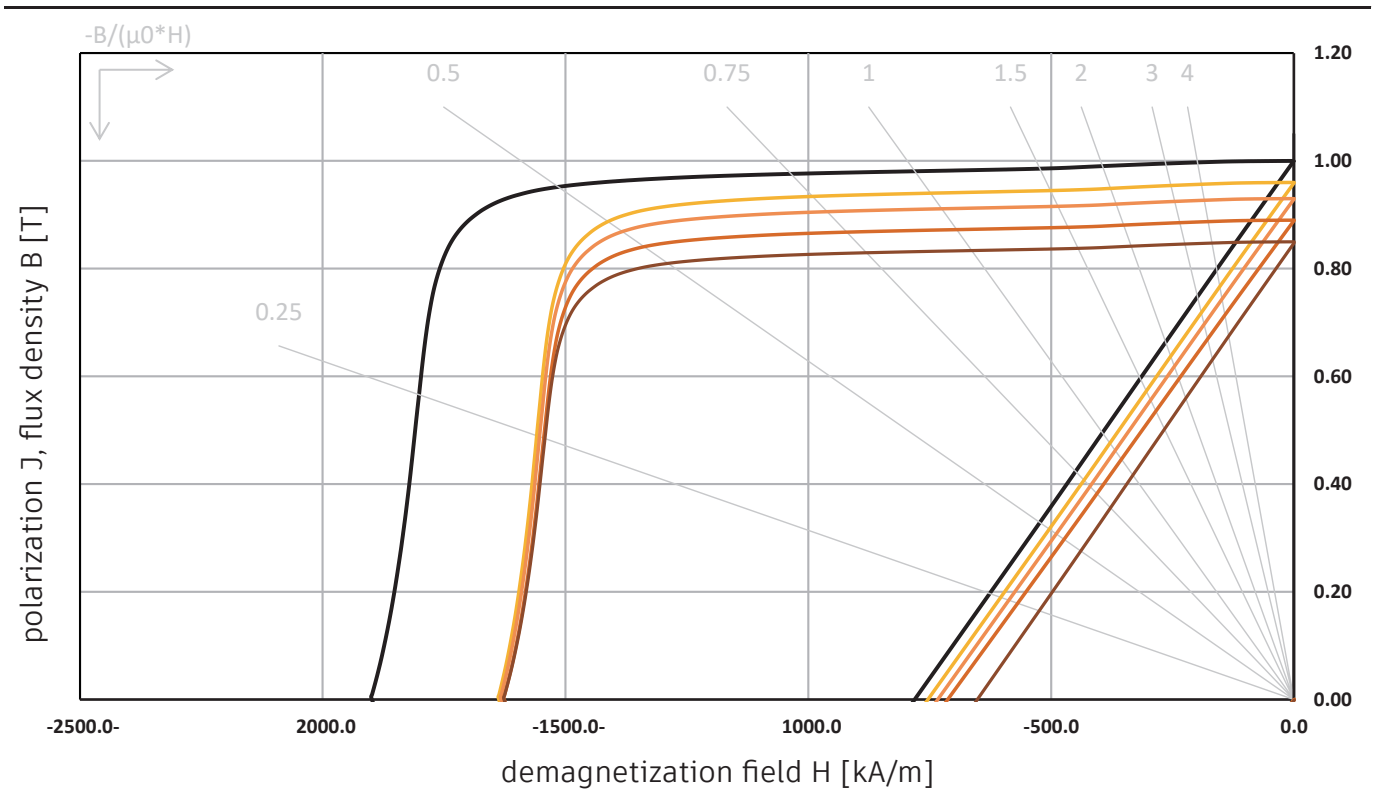
# Comparison of SmCo Magnets Grades

| | HS | BOMATEC | DURAMAG | DEXTERMAG | thyssenkrupp |
|---|---|---|---|---|---|
| SM1CO5 | HMS-16 | BMSG-16 | SC-1615 | | |
| | HMS-18 | BMS-18 | | | |
| | HMS-20 | BMS-20 | | S1818 | |
| | HMS-22 | BMS-22 | | S2215 | SM2CO17 160/120 |
| | HMS-24 | BMS-24 | SC-2416 | S2415 | SM2CO17 180/160 |
| | HMS-16S | BMS-16S | | | |
| | HMS-18S | BMS-18S | SC-1819 | | |
| | HMS-20S | BMS-20S | SC-2019 | S1820 | |
| | HMS-22S | BMS-22S | SC-2219 | S2020 | SM1CO5 170/160 |
| | HMS-24S | BMS-24S | | S2220 | |
| SM2CO17 | HMSG-22 | BMSG-22 | | | |
| | HMSG-24 | BMSG-24 | | | |
| | HMSG-26 | BMSG-26 | | | |
| | HMSG-28 | BMSG-28 | | | |
| | HMSG-30 | BMSG-30 | | S2616 | SM2CO17 225/160 |
| | HMSG-32 | BMSG-32 | SC-3018 | S2816 | |
| | HMSG-35 | BMSG-35 | SC-3215 | S3215 | |
| | HMSG-24H | HMSG-24H | SC-2228 | S2225 | SM2CO17 190/200 |
| | HMSG-26H | BMSG-26H | SC-2428 | S2425 | |
| | HMSG-28H | BMSG-28H | SC-2618 | S2625 | |
| | HMSG-30H | BMSG-30H | SC-2826 | S2815 | SM2CO17 225/160 |
| | HMSG-32H | BMSG-32H | | | |
| | HMSG-33H | BMSG-33H | | | |
| | HMSG-26M | BMSG-26M | | | |
| | HMSG-28M | BMSG-28M | | S2610 | |
| | HMSG-30M | BMSG-30M | | | |
| | HMSG-32M | BMSG-32M | | S3010 | |
| | HMSG-24L | BMSG-24L | | | |
| | HMSG-26L | BMSG-26L | | | |
| | HMSG-28L | BMSG-28L | | | |
| | HMSG-30L | BMSG-30L | | | |
| | HMSG-32L | BMSG-32L | | S3012 | |

# Demagnetization curve of $SmCo_5$ Magnets

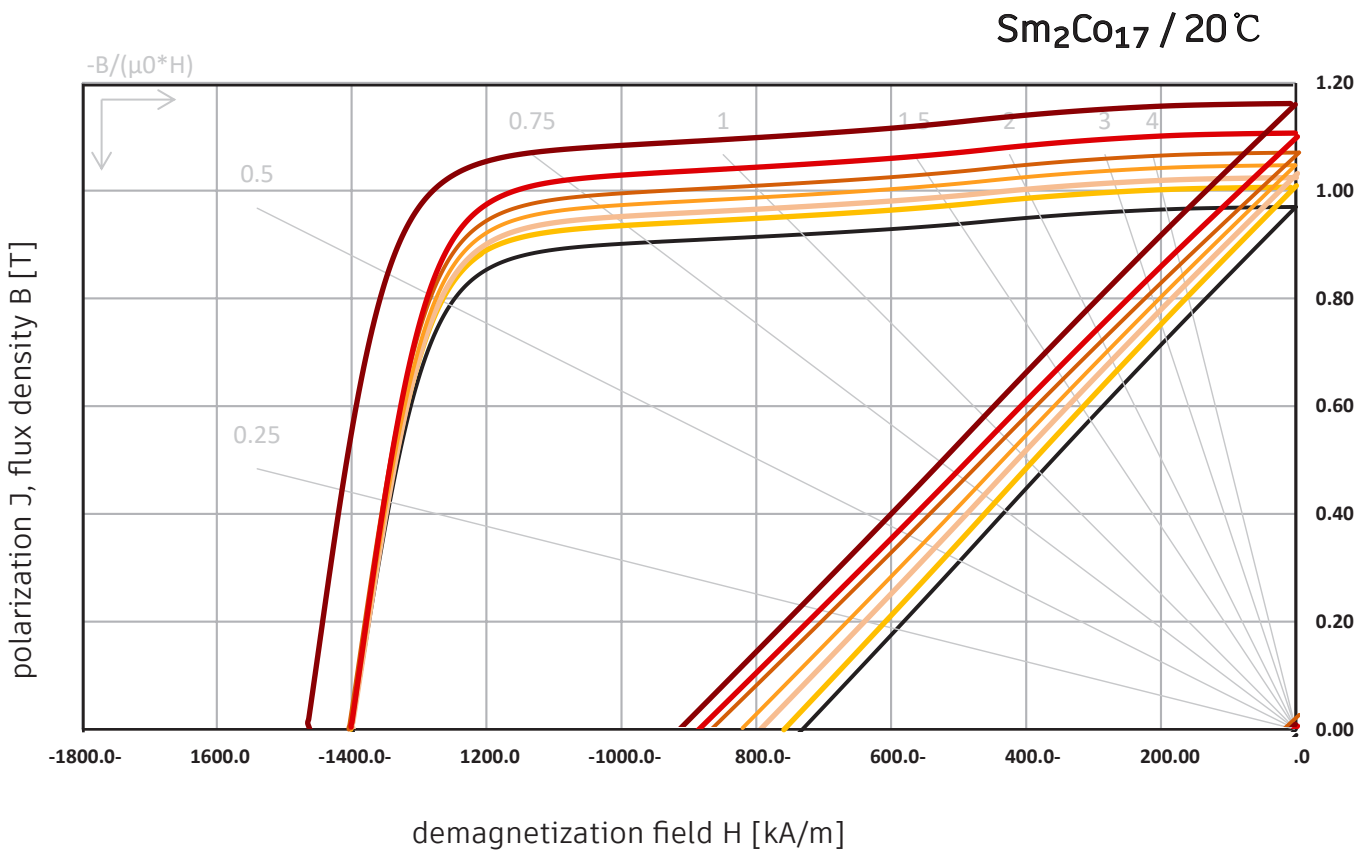



Material: ***HMS-24*** ***HMS-22*** ***HMS-20*** ***HMS-18*** ***HMS-16***

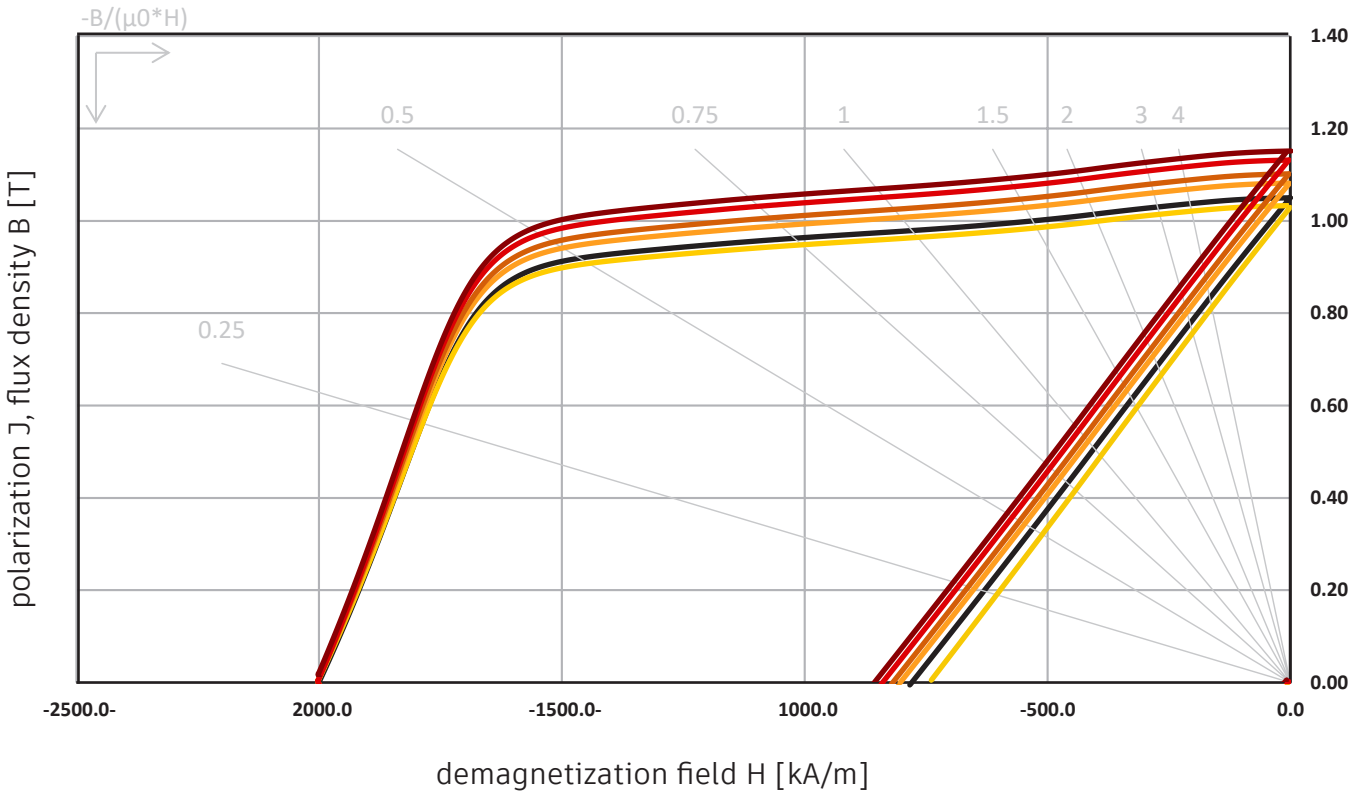



*Material:* ***HMS-24S*** ***HMS-22S*** ***HMS-20S*** ***HMS-18S*** ***HMS-16S***

# Demagnetization curve of $Sm_2Co_{17}$ Magnets

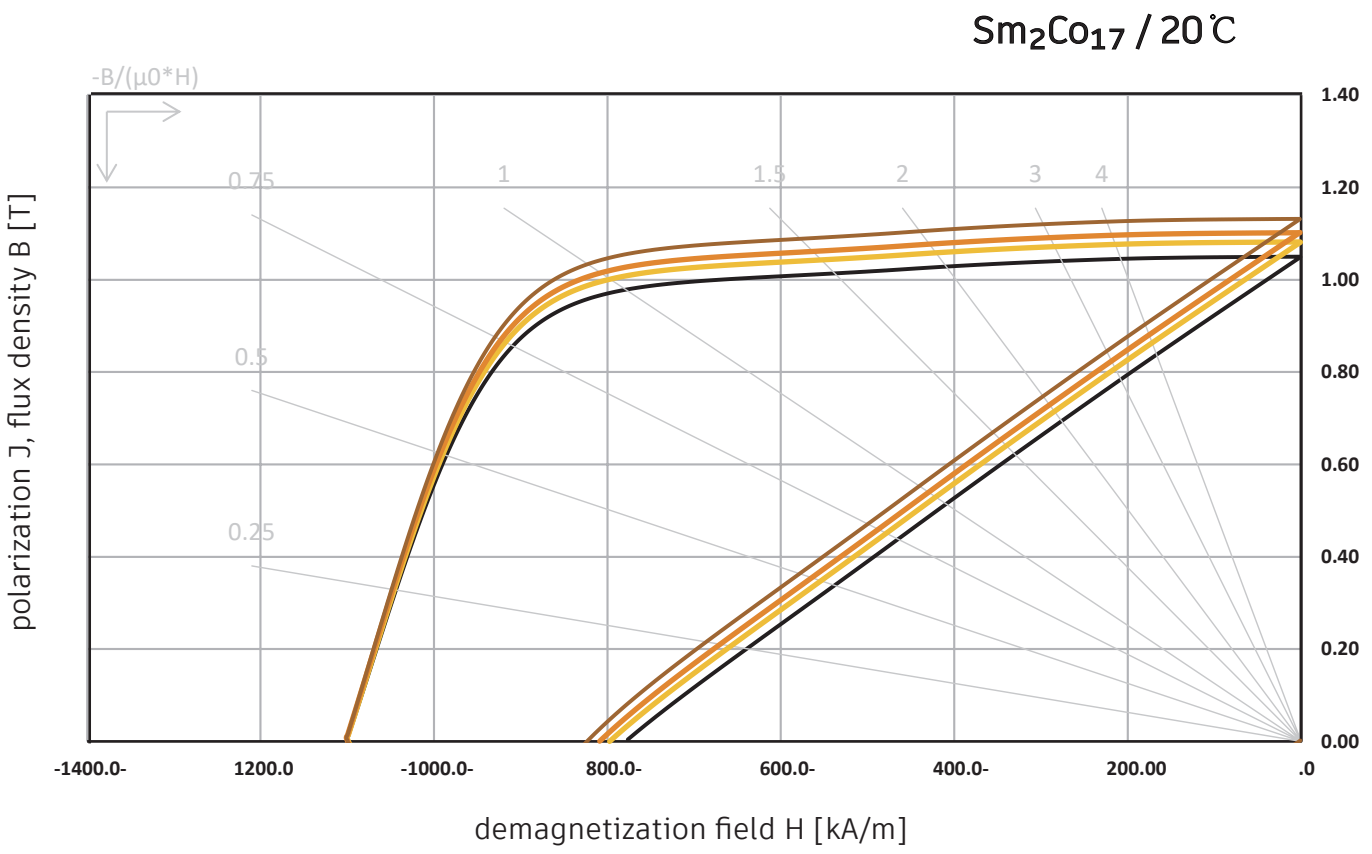



Material: HMS-35 HMS-32 HMS-30 HMS-28 HMS-26 HMS-24 HMS-22

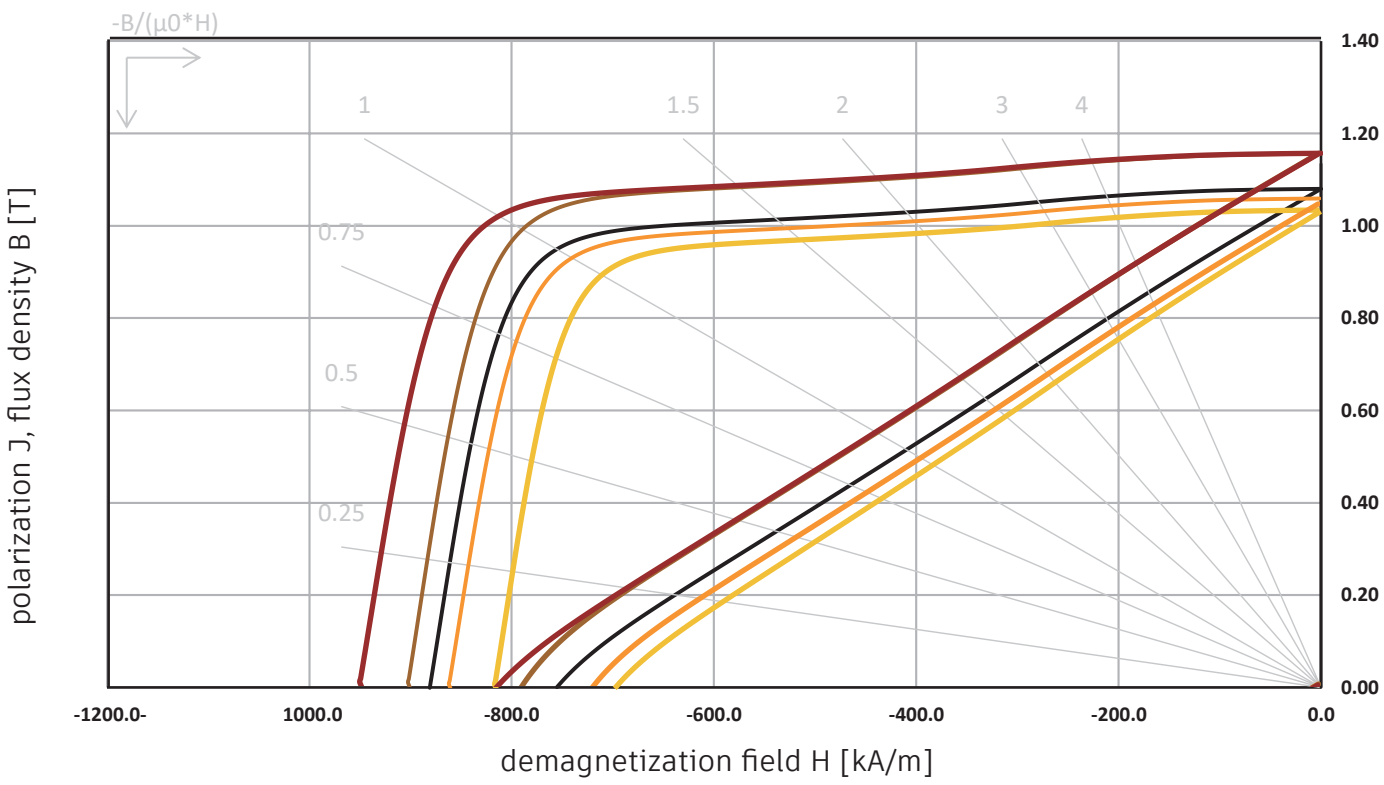



Material: HMS-33H HMS-32H HMS-30H HMS-28H HMS-26H HMS-24H

# Demagnetization curve of $Sm_2Co_{17}$ Magnets




Material: HMS-32M HMS-30M HMS-28M HMS-26M




Material: HMS-32L HMS-30L HMS-28L HMS-26L HMS-24L