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Magnetocaloric materials based on manganese pnictides

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Abstract: The article examines magnetocaloric materials based on manganese pnictides. Analysis of experimental data showed that the obtained data on the adiabatic change in temperature and the isothermal change in entropy are not always reliable. In the circuits, in the zone where there is no magnetic field, the working body is demagnetized, as a result of which the temperature of the working body decreases and heat is transferred to it from the heat source - the cooled body. After the establishment of temperature equilibrium, the cycle is repeated.

Keywords: Magnetic-caloric effect, isothermal, working surface cooling, magnetic, phase transitions, heat capacity, crystal, Heusler alloys, density.

Marganets pniktidlari asosidagi magnitokalorik materiallar

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Annotatsiya: Maqolada marganets pniktidlari asosidagi magnitokalorik materiallar ko‘rib chiqilgan. Eksperimental ma’lumotlar tahlili shuni ko‘rsatdiki, haroratning adiabatik o‘zgarishi va entropiyaning izotermik o‘zgarishi bo‘yicha olingan ma’lumotlar har doim ham ishonchli emas. Sxemalarda magnit maydon bo‘lmagan zonada ishchi jism magnitsizlanadi, buning natijasida ishchi jismning temperaturasi pasayadi va unga issiqlik manbai - sovitilayotgan jismdan issiqlik uzatiladi. Temperaturalar muvozanati o‘rnatilgandan so‘ng, sikl takrorlanadi.

Kalit so‘zlar: Magnitokalorik effekt, izotermik, ishchi yuzasi sovitish, magnit, fazaviy o‘tishlar, issiqlik sig‘imi, kristall, Heusler qotishmalari, zichlik

1. Kirish

Xona harorati oralig’ida ishlaydigan sodda, ekologik xavfsiz, energiya tejamkor va yuqori ishonchli sovutgichni yaratish hozirgi kunda nihoyatda dolzarbdir. Bu hozirda ishlayotgan sovutish tizimlariga nisbatan bir qator jiddiy e’tirozlar bilan bog‘liq. Ma’lumki, xususan, hozirgi vaqtda ishlatilayotgan sovutish tizimlaridan foydalanishda ozon qatlamining yemirilishi va global isish kabi jiddiy ekologik muammolarni keltirib chiqaradigan ishchi gazlarning (xladagentlarning) sizib chiqishi mumkin [4]. Sovutish qurilmalarida qo‘llanilishi mumkin bo‘lgan turli xil muqobil texnologiyalar orasida magnit-kalorik effekt (MKE) ga asoslangan magnit sovutish texnologiyasi butun dunyo bo‘ylab tadqiqotchilarning e’tiborini tobora ko‘proq jalb qilmoqda [1, 3].

2. Tadqiqot metodologiyasi

Bug‘-gaz aralashmalari o‘rniga ishchi suyuqlik sifatida marganets arsenidiga asoslangan qattiq fazali kompozitdan foydalanish, muzlatgichning texnologik sxemasini saqlagan holda, fazaviy o‘tish vaqtida yuqori magnit-kaloriya effektiga ega bo‘lgan texnologiyani ishlab chiqish mumkinligini tahlil qilinadi.

Mazkur ishda marganets pniktidlari asosidagi qotishmalarda magnit-struktura fazaviy o‘tishlarini o‘rganish ko’zda tutilgan [2, 3]. SHu munosabat bilan issiqlik sig‘imi va magnitlanishni o‘rganish orqali optimal faza tarkibi va gisterezis kengligini o‘rnatish uchun MnAs (Marganets arsenid) birikmalarining magnit maydonlarida magnitokaloriya xususiyatlarini o‘rganish taklif etiladi.

Magnit maydon ta’sirida paydo bo‘ladigan magnit-kalorik effektni (MKE) o‘rganish dolzarb vazifa bo‘lib, so‘nggi yillarda katta qiziqish uyg‘otmoqda [3, 4].

MKE magnit faza o‘tishlari hududida eng katta qiymatga yetadi. MKE tadqiqotlariga bo‘lgan qiziqish magnit sovutish mashinalarini yaratish uchun yuqori MKEga ega materiallarga bo‘lgan ehtiyoj bilan ham qo‘llab-quvvatlanadi. Yuqori MKEga ega materiallar alohida qiziqish uyg‘otadi. Bunday materiallarga Gd5(Si2Ge2), FeMnAsP, Heusler qotishmalari va boshqa magnit materiallar, shuningdek MnAs birikmalari kiradi [2, 5].

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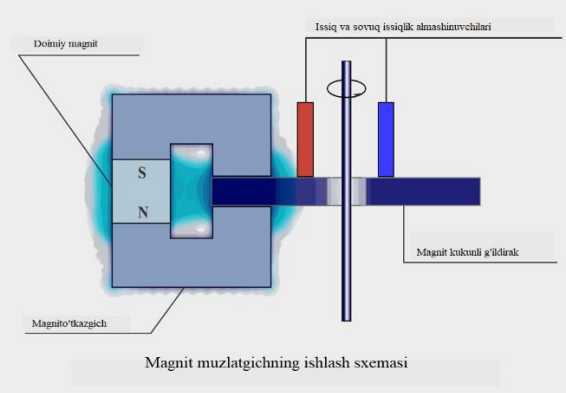
Magnit sovitish texnologiyasi – magnit maydon ta'siri ostida har qanday magnit material o'zining temperaturasini va entropiyasini o'zgartirish xususiyatlariga asoslangan, ya'ni ananaviy sovutish qurilmalaridagi gaz yoki parning siqilishi yoki kengayishida yuz bergani kabi [3, 6].

Magnit material temperaturasining o'zgarishi magnit material ichki eneregiyasining qayta taqsimlanishi natijasida uning atomlari va kristal panjaralari magnit momentining tizimlari oralig'ida yuzaga keladi. MKE o'zining maksimal qiymatiga magnit tartiblangan materiallarda yuzaga keladi, bunday materiallarga ferromagnetiklar, antiferromagnetiklar va boshqalar, magnit faza o'tishlarda (magnit tartibga solish temperaturalarida – Kyuri, Neelya) ega bo'ladi [7, 8, 10].

Magnit sovutiladigan jihozlarning asosiy afzalligi, par yoki gazning zichligi bilan taqqoslaganda qattiq yuzali materialning zichligi yuqori hisoblanadi. Entropiyaning o'zgarishi gazga nisbatan qattiq magnit materiallarning birlik hajmiga nisbatan 7 marta yuqori bo'ladi. Bu juda ixcham, ishchi yuza sifatida magnit materialdan foydalanib, sovutish qurilmasini tayyorlash imkonini beradi [7, 9]. Magnitning o'zining ishchi yuzasi, ananaviy sovutish qurilmalarida qo'llaniluvchi par gazli sovutish qurilmasining xlodogenti analogi vazifasini bajaradi, va magnitlanish va magnitsizlanish jarayoni siqilish va cho'zilish davrining analogi bo'ladi. Magnit-kalorik effekt (MKE) magnit maydon mavjud bo'lganda adiabatik qobiqda joylashgan magnitda qaytuvchanlik hodisasiga asosan issiqlikning yutilishi yoki chiqishida o'zini namoyon qiladi [4, 6, 8].



1-rasm. Magnit maydon mavjud bo'lganda adiabatik qobiqda joylashgan magnitda magnit-kalorik effekt (MKE)ni qaytuvchanlik hodisasiga tekshirishning texnologik sxemasi

Magnit sovutgich konstruksiyasi shunday yaratilganki, g'ildirak magnit maydon to'plangan magnitning ishchi oralig'i orqali aylanadi. Gadoliniyli segment magnit maydonga kirganda, gadoliniyda magnitokalorik effekt paydo bo'ladi va u qiziydi [4, 8]. Bu issiqlik suv bilan sovutilgan issiqlik almashtirgich tomonidan chiqariladi. Gadoliniy magnit maydon zonasini tark etganda esa, teskari effekt magnitokalorik ta'sir paydo bo'ladi va material yana sovutiladi, issiqlik almashtirgichni uning ichida aylanib yuradigan ikkinchi suv oqimi bilan sovutiladi. Bu oqim aslida magnit sovutgichning sovutgich kamerasini sovutish uchun ishlatiladi. Bunday qurilma ixcham bo'lib, deyarli shovqunsiz va tebranishsiz ishlaydi, bu uni bugungi kunda ishlatiladigan bug'-gazli sovutgichlardan ajralib turadigan jihati hisoblanadi [4, 9].

3. Xulosa

Magnit sovutgichlarni qo'llash asosida bug'-siqish sovutgichlaridan 20-30 foiz ko'proq energiya tejaydi. Ozon qatlamini yemiruvchi va issiqxona kimyoviy moddalari butunlay yo'q qilinadi, magnitli sovutgich ekologik toza texnologiyaga asoslanadi. Bu texnologiyadan foydalanish natijasida transport tizimlari yetakchi korxonalarining ishlab chiqish jarayonlarida qo'llash imkoniyatiga ega bo'ladi (vagon refrejeratorlarda, avtomobil transportlarining sovutish tizimlarida, maxsulotlarni saqlash omborxonalarida).

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