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GELIOPIROLIZ QURILMASIDA MUQOBIL YOQILG‘ILAR OLISHNING ISSIQLIK-TEXNIK REJIMINI TADQIQ QILISH

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Annotatsiya. Kirish. *Maqolada parabolik quyosh konsentratorli geliopiroliz qurilmasidaa kungaboqar o‘simligi chiqindilarini pirolizi jarayonini issiqlik-texnologik rejimi tadqiqoti natijalari keltirilgan. Geliopiroliz jarayonini tadqiqot qilish uchun tajriba parabolik quyosh kotsentratorli geliopiroliz qurilmasi yaratilgan. Kungaboqar o‘simligi chiqindisini termik qayta ishlash jarayonida chiquvchi mahsulotlarni haroratga bog‘liqligi va material balansi tajribalarda o‘rganilgan. Qurilmada o‘tkazilgan tajribalarda geliopiroliz reaktoriga yuklangan 1 kg kungaboqar o‘simligi chiqindisi pirolizi natijasida 63 % bioko‘mir, 10 % suyuq va 27 % gazsimon yoqilg‘ilar olishga erishilgan.*

Usul va materiallar. *Parabolik quyosh konsentratorli geliopiroliz qurilmasi reaktoriga yuklangan biomassadan ajralib chiqqan bioyoqilg‘ilarning material balansi laboratoriya sharoitida boshlang‘ich namligi 10 % va o‘lchami 6÷8 mm bo‘lgan holatda amalga oshirildi. Tadqiqotlar kungaboqar o‘simligi chiqindisida amalga oshirilgan.*

Natijalar. *Olib borilgan tajribalarga ko‘ra piroliz mahsulotlarining umumiy chiqish miqdori 350-400 °C harorat intervalida o‘zgarishiga kam bog‘liq bo‘lishi aniqlandi. Shunday qilib, tajribada yuklangan 1 kg kungaboqar o‘simligi chiqindisi pirolizi natijasida 63 % bioko‘mir, 10 % suyuq va 27 % gazsimon yoqilg‘ilar olishga erishildi.*

Xulosa. *Ishlab chiqilgan parabolik kuyosh konsentratorli geliopiroliz qurilmasi kunduzgi rejimda siklni amalga oshirish uchun xususiy ehtiyojiga sarflanadigan energiyani quyosh issiqligidan qoplash imkonini beradi. Parabolik quyosh konsentratorili geliopiroliz qurilmasida olib borilgan eksperimental tadqiqotlar natijasida kungaboqar o‘simligi chiqindisi pirolizidan qattiq, suyuq va gazsimon yoqilg‘i namunalari olish mumkinligi aniqlandi.*

Kalit so‘zlar: *quyosh energiyasi, parabolik konsentrator, biomassa pirolizi, muqobil yoqilg‘i, quyosh geliopiroliz qurilmasi, biomassa energiyasi, piroliz reaktori, issiqlik energiyasi.*

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ИССЛЕДОВАНИЕ ТЕПЛОТЕХНИЧЕСКОГО РЕЖИМА ПОЛУЧЕНИЯ АЛЬТЕРНАТИВНЫХ ТОПЛИВ В ГЕЛИОПИРОЛИЗНОЙ УСТАНОВКЕ

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Аннотация. Введение. *В статье представлены результаты исследования теплового технологического режима процесса пиролиза отходов подсолнечника в устройстве*

гелиопиролиза с параболическим солнечным концентратором. Для исследования процесса гелиопиролиза было создано экспериментальное устройство гелиопиролиза с параболическим солнечным концентратором. В процессе термической обработки отходов подсолнечника в экспериментах изучалась зависимость получаемых продуктов от температуры и материальный баланс. В экспериментах, проведенных с использованием устройства, пиролиз 1 кг отходов подсолнечника, загруженного в реактор гелиопиролиза, привел к получению 63% биоугля, 10% жидкого и 27% газообразного топлива.

Методы и материалы. *Материальный баланс биотоплива, выделенного из биомассы, загруженной в реактор устройства гелиопиролиза с параболическим солнечным концентратором, проводился в лабораторных условиях при начальной влажности 10% и размере 6-8 мм. Исследования проводились на отходах подсолнечника.*

Результаты. *Согласно проведенным экспериментам, установлено, что общий выход продуктов пиролиза мало зависит от изменения температуры в интервале 350-400°C. Таким образом, в результате пиролиза 1 кг отходов подсолнечника, загруженного в эксперименте, было получено 63% биоугля, 10% жидкого и 27% газообразного топлива.*

Заключение. *Разработанное устройство гелиопиролиза с параболическим солнечным концентратором позволяет использовать солнечное тепло для покрытия энергии, необходимой для проведения циклов в дневное время. Экспериментальные исследования, проведенные с использованием устройства гелиопиролиза с параболическим солнечным концентратором, показали, что возможно получение образцов твердого, жидкого и газообразного топлива из отходов подсолнечника.*

Ключевые слова: *солнечная энергия, параболический концентратор, пиролиз биомассы, альтернативное топливо, устройство гелиопиролиза, энергия биомассы, пиролизный реактор, тепловая энергия.*

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STUDYING THE THERMAL-TECHNICAL REGIME OF THE OBTAINED ALTERNATIVE FUELS IN THE HELIOPYROLYSIS DEVICE

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Annotation. Introduction. *The article presents the results of a thermal-technological regime study of the pyrolysis process of sunflower plant waste in a parabolic solar concentrator heliopyrolysis device. An experimental parabolic solar concentrator heliopyrolysis device was created to investigate the heliopyrolysis process. In the process of thermally processing sunflower plant waste, the dependency of the resulting products on temperature and the material balance were studied in experiments. In experiments conducted with the device, the pyrolysis of 1 kg of sunflower plant waste loaded into the heliopyrolysis reactor resulted in the production of 63% biochar, 10% liquid, and 27% gaseous fuels.*

Methods and Materials. *The material balance of biofuels separated from the biomass loaded into the parabolic solar concentrator heliopyrolysis reactor was carried out in laboratory conditions with an initial moisture content of 10% and a size of 6-8 mm. The studies were conducted on sunflower plant waste.*

Results. *According to the experiments conducted, it was found that the total yield of pyrolysis products varies little within the temperature range of 350-400°C. Thus, the pyrolysis of 1 kg of sunflower plant waste loaded into the experiment resulted in the production of 63% biochar, 10% liquid, and 27% gaseous fuels.*

Conclusion. *The developed parabolic solar concentrator heliopyrolysis device allows the use of solar heat to cover the energy needed for conducting cycles during daylight hours. Experimental studies carried out with the parabolic solar concentrator heliopyrolysis device revealed that it is possible to obtain solid, liquid, and gaseous fuel samples from the pyrolysis of sunflower plant waste.*

Keywords: *solar energy, parabolic concentrator, biomass pyrolysis, alternative fuel, solar heliopyrolysis device, biomass energy, pyrolysis reactor, thermal energy.*

Iqtibos uchun: *Almardanov H.A., Mamatova M.Sh. Geliopiroliz qurilmasida olingan muqobil yoqilg‘ilarning issiqlik-texnik rejimini tadqiq qilish. Muqobil energetika. 2024. №1 (12). 70-76 b.*

Kirish

Hozirgi vaqtda quyosh energiyasidan yuqori harorat talab etadigan texnologik jarayonlarda foydalanish uchun quyosh konsentratorlarini qo‘llanishi muhim ahamiyatga ega. Jahonda va O‘zbekistonda ham keyingi yillarda quyosh energiyasidan turli texnologik jarayonlarda foydalanish bo‘yicha ilmiy tadqiqotlar olib borilgan va amaliy natijalarga erishilgan [1-11].

Yuqori haroratli biomassa pirolizi texnologiyasida ham quyosh energiyasidan foydalanish istiqbolli yo‘nalishlardan hisoblanadi. Quyosh energiyasidan foydalangan holda biomassa va organik chiqindilardan piroliz usulida yoqilg‘i va energiya (issiqlik va elektr energiyasi) ishlab chiqarish, birinchi navbatda qishloq aholisi turar joylari, fermer xo‘jaliklari va yakka tartibdagi uylar kabi markazlashtirilgan energiya ta’minoti tizimlaridan uzoqda joylashgan energiya iste’molchilari uchun muhim ahamiyatga ega. Shu sababli yoqilg‘i, issiqlik va elektr energiyasini ishlab chiqarish uchun o‘simlik biomassasini qayta ishlash asosan qishloq aholisini, ayniqsa, energiya yetishmaydigan hududlarni energiya bilan ta’minlash muhim vazifa hisoblanadi.

Uslub va materiallar

Parabolik quyosh konsentratorli geliopiroliz qurilmasi reaktoriga yuklangan biomassadan (kungaboqar o‘simligi) ajralib chiqqan bioyoqilg‘ilarning material balansi laboratoriya sharoitida quyidagi metodika bo‘yicha olib borildi [12]. Tajriba boshlanishidan avval boshlang‘ich namligi 10 % va o‘lchami 6÷8 mm bo‘lgan mahsulotlardan namunalar tayyorlandi (1-rasm). Yuklanadigan mahsulotlarning massasi elektron tarozida (Electronic Sf-400), namligi esa raqamli universal AR971 rusumli namlik o‘lchash asbobi yordamida ±2% aniqlikda, reaktordagi harorat rejimi Mobile-CASSY 2 termometri va bimetalik termometr (Pakkens) yordamida nazorat qilindi. Quyosh nurlanish radiatsiyasi Photovoltaic Data Logger MacSolar (yorug‘lik o‘lchash oralig‘i: 0….1500 W/m^2 gacha; harorat o‘lchash oralig‘i: -40 dan 85 °C gacha; harorat o‘lchash aniqliligi: ±0,1°C) aktinometri orqali o‘lchandi.

Biomassa pirolizi uchun kungaboqar o‘simligi chiqindisi tanlab olindi hamda 6-8 mm kattaliklarda maydalandi. Kungaboqar o‘simligi chiqindisini pirolizga tayyorlash jarayoni 1-rasmda keltirildi.

1-rasm. Kungaboqar o‘simligini piroliz qilish jarayoni.
Figure 1. Process of pyrolysis of sunflower plant.

Olib borilgan tadqiqotlar shuni ko‘rsatadiki bir tup kungaboqar o‘simligidan o‘rtacha 0,8÷1,5 kg gacha biomassa chiqindisi yuzaga keladi va uni piroliz usulida to‘liq qayta ishlash natijasida

muqobil yoqilg‘ilar olish imkoniyati mavjud bo‘lib, uning issiqlik-fizik xossalari 1-jadvalda keltirildi.

1-jadval

Kungaboqar o‘simligi chiqndisining issiqlik-fizik xossalari

Table 1

Thermal and physical properties of sunflower plant waste

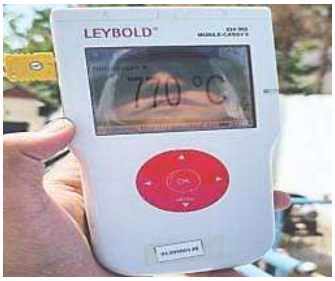
Ko‘rsatkichlar	Qiymati
Zichligi, kg/m^3	130–140
Namligi, %	20-25
O‘lchami, mm	6-10
Issiqlik o‘tkazuvchanlik koeffitsiyenti, Vt/m·°C	0,046 - 0,093
Issiqli sig‘imi, J/kg·°C	1600-2300
Yonish issiqligi, MJ/kg	17

Kungaboqar o‘simligi pirolizi bo‘yicha tadqiqotlar laboratoriya sharoitida quyidagi tabiiy sharoitlarda olib borildi. Tajribalar diametri 1,8 m, aperturasi 2,54 m^2, fokuslanish masofasi 0,7 m, konsentratsiya koeffitsienti 126 bo‘lgan parabolik konsentratorda amalga oshirildi [13-18]. Bunda hajmi 0,003 m^3 va issiqlik almashinish yuzasi 0,02 m^2 bo‘lgan reaktor namunasi tayyorlandi. Tajribalar Qarshi (O‘zbekiston) shahri sharoitida 2023 yil 26 avgust 12^{00} dan 14^{00} gacha bo‘lgan vaqt oralig‘ida, tashqi muhitning o‘rtacha harorati 36,4 °C, quyosh radiatsiyasining o‘rtacha qiymati 910÷960 W/m^2 bo‘lganda o‘tkazildi. Ishlab chiqilgan qurilma yordamida 1 kg biomassani piroliz qilish mumkin.

Natijalar va munozara

Ushbu tadqiqotda parabolik quyosh konsentratorli geliopiroliz qurilmasi reaktoriga yuklangan kungaboqar o‘simligidan ajralib chiqqan yonuvchi mahsulotlarning material balansi tahlil qilindi. Parabolik quyosh konsentratori yordamida o‘tkazilgan tajribalarda Qarshi shahri sharoitida qurilma reaktorida o‘rtacha 350÷500 °C harorat hosil qilish mumkinligi tajribalarda aniqlandi (2-3-rasmlar).

2-rasm. Reaktor ichida hosil bo‘lgan harorat (26.08.2023 yil)
Figure 2. The temperature inside the reactor (26.08.2023)



3-rasm. Reaktor tubidagi harorat.
Figure 3. Temperature at the bottom of the reactor.

Geliopiroliz reaktorining harorat rejimi reaktorga kungaboqar o‘simligi chiqindisi yuklanganda tadqiq qilindi hamda natijalar 2-jadvalda keltirildi.

2-jadval

Geliopiroliz reaktorining harorat rejimi tadqiqoti natijalari

Table 2

The results of the study of the temperature profile of the heliopyrolysis reactor

T/r	Vaqt	Tushadigan quyosh radiatsiyasi, q_r, W/m^2	Tashqi havo harorati $t_{t.x}$, ℃	Reaktorning turli nuqtalaridagi haroratlar, t_r, ℃				Reaktordagi o‘rtacha harorat, $t_{o'rt}$, ℃
				1	2	3	4	
1	12^{00}	910	35,4	656	237	151	115	289
2	12^{30}	925	35,9	801	258	165	131	338
3	13^{00}	950	36,1	817	285	178	145	356
4	13^{30}	960	36,6	820	301	227	152	375
5	14^{00}	950	36,9	807	290	217	140	363

Geliopiroliz qurilmasi reaktoriga yuklangan kungaboqar o‘simligi chiqindisidan olingan muqobil yoqilg‘ilarning material balansi bo‘yicha olingan natijalar 3-jadvalda keltirildi.

3-jadval

Kungaboqar o‘simligi chiqindisidan muqobil yoqilg‘i olish uchun o‘tkazilgan tajriba natijalari

Table 3

Results of an experiment to obtain alternative fuel from sunflower plant waste

№	Yuklangan hom ashyo turi	Yuklangan xom ashyo massasi, *m, kg*	Yuklangan xom ashyoning boshlangich namligi, *%*	Yuklangan xom ashyoning dastlabki harorati, *t, °C*	O‘ rtacha quyosh radiatsiyasi, q_r, W/m^2	Reaktordagi o‘ rtacha harorat , $t_{o'rt}$, *°C*	Jarayon vaqti, *min*	Piroliz mahsulotlari		
								suyuq, *kg*	gaz, *kg*	qattiq, *kg*
1	Kungaboqar o‘simligi chiqindisi	1,0	10	27	940	430, 25	120	0,10 (10 %)	0,27 (27 %)	0,63 (63 %)

Olib borilgan tajribalarga ko‘ra kungaboqar o‘simligi chiqindisi pirolizi 150-400 °C harorat intervalida yuqori intensivlikka ega bo‘ladi, piroliz jarayonida chiqadigan suyuq va gazsimon yoqilg‘ilarning miqdori harorat ortishi bilan ortib borishi qayd qilindi. Tajriba natijalari tahliliga ko‘ra, piroliz mahsulotlarining umumiy chiqish miqdori 350-400 °C harorat intervalida o‘zgarishiga kam bog‘liq bo‘lishi aniqlandi. Shunday qilib, tajribada yuklangan 1 kg kungaboqar o‘simligi chiqindisi pirolizi natijasida 63 % bioko‘mir, 10 % suyuq va 27 % gazsimon yoqilg‘ilar olishga erishildi.

Xulosa

Bajarilgan tajriba tadqiqotlari shuni ko‘rsatadiki, ishlab chiqilgan parabolik kuyosh konsentratorli geliopiroliz qurilmasi kunduzgi rejimda siklni amalga oshirish uchun xususiy ehtiyojiga sarflanadigan energiyani quyosh issiqligidan qoplash imkonini beradi. Parabolik quyosh konsentratorili geliopiroliz qurilmasida olib borilgan eksperimental tadqiqotlar natijasida kungaboqar o‘simligi chiqindisi pirolizidan qattiq, suyuq va gazsimon yoqilg‘i namunalari olindi. Taklif etilgan parabolik quyosh konsentratorli geliopiroliz qurilmasida yiliga 1 tonnagacha kungaboqar o‘simligi chiqindisini qayta ishlashda 270÷300 m^3 gacha gazsimon, 100÷150 kg gacha suyuq va 550÷600 kg gacha qattiq muqobil yoqilg‘ilar olindi. Ushbu parabolik quyosh konsentratorli geliopiroliz qurilmasi kungaboqar o‘simligi yetishtiruvchi va qayta ishlovchi klasterlar, fermer xo‘jaliklari va korxonalar uchun mo‘ljallangan.

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