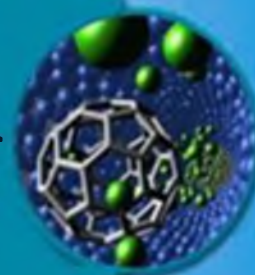




FAN VA TEXNOLOGIYALAR TARAQQIYOTI

DEVELOPMENT OF SCIENCE AND TECHNOLOGI



2
2026

Tahririyat hay'ati raisi:
SIDDIQOVA S.G'. –
Buxoro davlat texnika universiteti rektori

Muovini:
NIZAMOV A.B. –
BuxDTU ilmiy ishlar va innovatsiyalar bo'yicha prorektori
Tahrir hay'ati:

MUQIMOV K.M. – O'zR FA akademigi (O'zMU)
JALILOV A.T. – O'zR FA akademigi (Toshkent kimyo-texnologiya ITI)
NEGMATOV S.N. – O'zR FA akademigi ("Fan va taraqqiyot" DUK)
BAHODIROV G'.A. – t.f.d., professor, O'zR FA bosh ilmiy kotibi
XAMIDOV O.X. – iqtisod fanlari doktori, professor (BuxDU)
JALILOV T.K. – iqtisod fanlari doktori (DSc), professor (TKTI)
PARDAYEVA M.D. – BuxDTU yoshlar masalalari va ma'naviy-ma'rifiy ishlar bo'yicha birinchi prorektori, falsafa fanlari doktori (DSc)
XOJIYEV A.X. – o'quv ishlari bo'yicha prorektor, texnika f.f.d. (PhD)
SAIDOV S.B. – Buxoro DTU moliya va iqtisod ishlari bo'yicha prorektori
QURBONOV J.M. – texnika fanlari doktori, professor (Samarqand ISI)
ADIZOV B.Z. – texnika fanlari doktori (DSc), pprofessor, O'zRFA UNKI
ASTANOV S.X. – fizika-matematika fanlari doktori, professor
RAXMONOV X.Q. – texnika fanlari doktori, professor
VOXIDOV M.M. – texnika fanlari doktori, professor
JO'RAYEV X.F. – texnika fanlari doktori, professor
SADULLAYEV N.N. – texnika fanlari doktori (DSc), professor
MAJIDOV Q.X. – texnika fanlari doktori, professor
FOZILOV S.F. – texnika fanlari doktori, professor
ISABAYEV I.B. – texnika fanlari doktori, professor
ABDURAHMONOV O.R. – texnika fanlari doktori, professor
GAFUROV K.X. – texnika fanlari doktori (DSc), professor
XAYDAROV A.A. – texnika fanlari doktori (DSc), dotsent
JO'RAYEV F.O'. – texnika fanlari doktori (DSc), professor
MURADOVA F.R. – pedagogika fanlari doktori (DSc), professor
JUMAYEV M.R. – fizika-matematika fanlari doktori (DSc), professor
YUNUSOVA G.S. – falsafa fanlari doktori (DSc), professor
BOBOYEV A.Ch. – iqtisodiyot fanlari nomzodi, professor
TO'XTAYEVA Z.Sh. – texnika fanlari doktori (DSc), professor
MAXMUDOV M.J. – texnika fanlari doktori (DSc), professor
HAYITOV R.R. – texnika fanlari doktori (DSc), professor
BOZOROV G'.R. – texnika fanlari doktori (DSc), professor
BOLTAYEV Z.I. – fizika-matematika fanlari doktori (DSc), professor
OLTIYEV A.T. – texnika fanlari doktori, (DSc)
JALILOV R.B. – texnika fanlari doktori (DSc), professor
MAXMUDOV M.I. – texnika fanlari doktori (DSc), professor
MAJIDOVA N.Q. – texnika fanlari doktori (DSc), professor
AXMEDOV V.N. – texnika fanlari doktori (DSc), professor
MAXMUDOV R.A. – texnika fanlari doktori (DSc), professor
PULATOVA M.I. – fizika-matematika fanlari nomzodi, professor
RAHMATOV Sh.A. – pedagogika fanlari bo'yicha falsafa doktori (PhD)
OCHILOV A.R. – texnika fanlari doktori (DSc), dotsent
O'RINOV U.A. – pedagogika fanlari doktori (DSc), professor
PO'LATOVA S.U. – texnika fanlari doktori (DSc), professor
SAMIYEVA Sh.X. – pedagogika fanlari doktori (DSc), professor
TESHAYEV M.X. – fizika-matematika fanlari doktori (DSc), professor
XAITOV V.U. – iqtisodiyot fanlari doktori (DSc), dotsent
XOJIYEV Sh.M. – texnika fanlari doktori (DSc), dotsent
XAYITOV Sh.N. – iqtisodiyot fanlari doktori (DSc), dotsent
ZOIROV E.X. – falsafa fanlari doktori (DSc), dotsent
NARZIYEV M.S. – texnika fanlari doktori (DSc), dotsent
NAMAZOVA N.J. – iqtisodiyot fanlari b.f.d. (PhD), dotsent

Bosh muharrir: DO'STOV H.B. – kimyo fanlari doktori, professor

Muharrirlar: Artikova M.M., Istamova G.X.
Musahhih: Barakayeva D.F.

FAN VA TEXNOLOGIYALAR
TARAQQIYOTI
ILMIY-TEXNIKAVIY JURNAL

DEVELOPMENT OF SCIENCE
AND TECHNOLOGY
SCIENTIFIC AND TECHNICAL JOURNAL

Jurnal O'zbekiston matbuot va axborot agentligi Buxoro viloyati boshqarmasida 2014 yil 22-sentyabrda № 05-066-sonli guvohnoma bilan ro'yxatga olingan

Muassis:
Buxoro davlat texnika universiteti

Jurnal O'zbekiston Respublikasi Vazirlar Mahkamasi huzuridagi OAK Rayosatining 2017 yil 29-martdagi №239/5-sonli qarori bilan dissertatsiyalar asosiy ilmiy natijalarini chop etish tavsiya etilgan ilmiy nashrlar ro'yxatiga kiritilgan. 2019 yilda O'zbekiston Respublikasi OAK Rayosatining qarorlari bilan qayta ro'yxatdan o'tkazilgan.

Tahririyat manzili:
200117, Buxoro shahri, Q. Murtazoyev ko'chasi, 15-uy, Buxoro davlat texnika universiteti

Tel: 0(365) 223-92-40

Faks: 0(365) 223-78-84

E-mail: fantt_jurnal@umail.uz

Jurnalning to'liq elektron varianti bilan <http://journal.bstu.uz> sayti orqali tanishish mumkin.

Ushbu jurnalda chop etilgan materiallar tahririyatning yozma ruxsatisiz to'liq yoki qisman chop etilishi mumkin emas. Tahririyatning fikri mualliflar fikri bilan har doim ham mos tushmasligi mumkin. Jurnalda yoritilgan materiallarning haqqoniyligi uchun maqolalarning mualliflari va reklama beruvchilar mas'uldirlar.

MUNDARIJA – CONTENT

TEXNIKA, TEXNOLOGIYA VA JHOZLAR	
Kayumov U.E., Pardayeva Sh.S., Istamov M.F. Konchilik sanoatida qo‘llaniladigan markazdan qochma nasoslarning ekspluatatsiyasining xususiyatlari	5
Majitov J.A., Narzulleyev M.N. Yakka iste‘molchilarga mo‘ljallangan biogaz qurilmasining tajriba tadqiqotlari.....	12
Fattoyev F.F., Hamidov A.X. o‘zbekiston respublikasida standartlashtirish bo‘yicha texnik qo‘mitalarning faoliyatini baholashda xalqaro tajribalarning o‘rni va ahamiyati.....	22
Taslimov A.D., Raximov F.M., Norqulov A.O. Navoiy shahar transformator podstansiyalarida faza balanslashni joriy etish bo‘yicha ustuvorlashtirish modeli.....	32
Mavlonova I.R. Pilla losi va sannohidan momiq olish hamda qayta ishlash istiqbollari.....	38
Narziev M.S., Axmedov V.N., Mavlonova I.R., Qodirov M.M. Pilla losini qo‘shimchalardan va seritsindan tozalashda tabiiy komponentlarni qo‘llash texnologiyasi.....	44
Мусурмонов И.М., Рахматова С.Ф., Жумаев А.А., Жумаева Н.К. Результаты исследования структурного состояния износостойких белых чугунов.....	48
Yusubaliyev A., Sharipov Sh.N. Beda urug‘ligini elektr maydonida ekishga tayyorlashning ayrim tadqiqot natijalari	54
KIMYO VA KIMYOVIY TEXNOLOGIYALAR	
Шарипбаев С.С. Влияние морфологии фотоанодов DSSC на характеристики фотоэлектрических преобразователей.....	58
Berdiyev D.M., Liang Zhenglong., Ibroximova M.M. Nikel asosli olovbardosh qotishmani qayta eritishda xossalarga ta’siri.....	63
Hamroyev O.O., Sattorov M.O., Ochilov A.A. Kimyoviy ishlov berish orqali olingan quduq mahsulotiga deemulgatorning xlorid kislotasi ishtirokida ta’sirining samaradorligini tadqiq etish..	68
Maxmudov M.J., Ne‘matov X.I., Shoymardonov O‘.B. Gazlarni absorbsion quritishda qo‘llaniluvchi glikollarning asosiy xossalari tavsifi va jarayonning samaradorligiga ta’sir etuvchi omillar tahlili.....	77
Xo‘jaqulov A.F., Rasulov U.A., Raximov Z.Z. Navbaxor koni bentonitini sulfat kislotasi bilan faollanishi.....	81
Жумаева А.А., Амонов М.Р. Базальт асосида олинган ПВХ композицияларнинг термик барқарорлигини ўрганиш.....	87
Фозилов С.Ф., Махмудов М.Ж., Муртазаев Ф.И. Маҳаллий паст октанли автомобил бензинининг физик-кимёвий хossalари ва унинг бензол сақлаган фракциясини аниқлаш..	92
Sharipov N.Z., Fazlitdinov J.R. Ko‘mir yoqilg‘isi yonadigan tizimlardan chiqayotgan zararli tutun gazlarini tozalash texnologiyasi.....	99
Саатов С.К., Шарипов К.К. Полевые исследования по оценке скорости износа стенки трубопровода в процессе эксплуатация.....	104
Джураева Г.Х., Тошқобилов Ж.Ш., Абдурахимов И.Э. Синтез моноциклических ароматических углеводов.....	110
Toshpulatov D.T., Abdumuminova O.B., Xushvaqtoev I.G‘., Pardaboyeva M.T., Toshtemirov A.Sh., Tashpulatov X.Sh. [Co(tmphen) ₃](PF ₆) ₂ gomoleptik kompleksning tuzilishini o‘rganish.....	114
Bokiyeva Sh.K. Konlardagi qatlam suvlarini tozalashda adsorbentlar olish texnologiyasi.....	118

MASHINASOZLIK VA ENERGETIKA

Murodov K.J. Yo‘lning sun‘iy notekislik qismiga birlashtirilgan mexanik-quyoshli gibrid qurilma yordamida elektr energiyasi ishlab chiqarish.....	123
Бафоев Д.Х. Повышение эффективности упрочнения деталей из титановых сплавов.....	127
Boixanov Z.U. Asinxron motorlarning elektromagnit holatini aniqlash va monitoring qilish usullari.....	135
Juraqulov A.X. O‘zbekiston iqlim sharoitlari uchun fokuslovchi quyosh kollektorlarini ishlab chiqish.....	139
Makhmudov M.I., Kushshayeva M.R., Nurov S.S., Timirov H.N., Sayfiyev H.O. The effect of dust accumulation on the efficiency of solar panels and methods for its detection.....	146
A‘zamov S.S. On-Grid quyosh fofoelektrik sistemasi energiya samarador ko‘rsatkichlarini tadqiqi.....	150
Nizomov J.A. Asinxron motorning MATLAB immitasion modeli orqaliy turli xil ish rejimlarini kuzatish.....	155
Bafojev D.X. Materiallar sirtida ko‘p elementli qoplamalar hosil qilish.....	160
Nizamov. J.A. Sun‘iy neyron tarmog‘i yordamida asinxron motorlarning nosozliklarni monitoring qilish va diagnostika qilish.....	166
Xaydarov X.M. Quyosh panellaridan ta‘minlangan elektr tarmoqlaridan ta‘minlanadigan nasos qurilmalari ish rejimlari va energiya iste‘mol dinamikasini yil davomida mavsumiy o‘zgarishi...	172
Murodov K.J. Vertikal suyuqlik oqimlari asosida binolarda energiya ishlab chiqarishning yangi yondashuvi.....	177
Тоиров З., Сайфиддинов Қ.Э. Анализ ветрового энергетического потенциала в бухарской области республики узбекистан с использованием распределения Вейбулла....	181
Sharipov J.O., Begmurodov A.F. Detallarni korroziya bardoshlilikini oshirish uchun zamonaviy yechim va uni qo‘llash jarayoni.....	188
Mirzamaxmudov U.A., Sharibayev N.Yu., Murodov R.S. Ipak qurti urug‘chiligida kapalak chiqarishni sinxronlashtiruvchi LED fotoperiod moslamasining elektrotexnik asoslari.....	192

INFORMATIKA VA AXBOROT – KOMMUNIKATSION TIZIMLAR

Rakhmonov I.U., Niyozov N.N., Nematov L.A. Investigation of insulation degradation mechanisms in centralized inverters and development of efficient data exchange methods in wireless sensor networks.....	197
Xamroyev X.X., Bibutov N.S., Xabibov F.Yu. “Materiallar qarshiligi” kursida masalalarni kompyuterli modellashtirish.....	202
Rakhmonov I.U., Kurbonov N.N., Nematov L.A. Parameter optimization of medium- and short-term forecasting systems of lightning activity.....	208
Sharifbaev A.N. Improving retrieval-augmented generation pipelines through knowledge graph integration.....	213

OZIQ-OVQAT SANOATI TEXNOLOGIYALARI

Axmedova M.B. Ikkilamchi mahalliy xomashyolardan xamirturush tayyorlash usullari.....	220
Ravshanov S.S., Shaxriddinov F.F., Suyunova L.A., Karimov D.T. Kompozit nonlarning oziqaviy tarkibi, xamir reologiyasi va sensor xususiyatlari.....	224
Ибрагимов А.К., Махмудов Р.А. Анализ химического состава и функционально-технологических свойств ингредиентов сырья для приготовления майонеза.....	229

Kuliyev N.Sh. Ko‘pik va emulsion strukturalarning shakllanishida meva va sabzavot sharbati komponentlarining ishtiroki.....	236
Kurbanov M.T., Axmedova M.B. Soya siqilmasidan parrandalar uchun ekologik toza omuxta yem tayyorlash texnologiyasini takomillashtirish.....	245
Хужакулов У.К., Мажидова Н.К., Мажидов К.Х. Исследование влияния воздействия электромагнитного поля на сохранность и показатели качества местных сортов томатов...	249
Yoqubov M.E., Khaitov R.A. Environmentally efficient helioconvective technology for dehulling pumpkin seeds.....	260
Mahmudov M.S., Mamajanov G‘.O., Toshmatov Y.R. <i>Phragmites communis trin</i> o‘simligidan ishqorli va kislotali usulda olingan sellyuloza namunalarning termik analizi	266
Турсунова Н.Н. Общая характеристика сои и основные направления использования соевых продуктов.....	270

TO‘QIMACHILIK VA YENGIL SANOAT TEXNOLOGIYALARI

Amonov A.R, Muxammedjanov M.M. Tikuv mashinasi qayishqoq tayanchlari bo‘lgan bosh valning kritik tebranishlari tahlili.....	278
Behbudov Sh.H., Samadova M.O. Ip va matoga ignaning ta‘sirini vertikal tebranishdagi chastotasining tahlili.....	282
To‘raqulova B.B., Temirova G.I., Toshpo‘latova G.R. An‘anaviy naqsh va bezaklarni modernizatsiya qilishning usullari.....	285
Нигматова Ф.У., Эргашева Н.Дж., Кодирова Д.Х., Шомансурова М.Ш., Музаффарова Ф. Ретроспективные исследования современного дизайна меховой одежды за период 1980-2025 гг	292
Jumaniyazov K., Salimov Sh.H., Nazarov R.A. Pnevмомеханик yigirish mashinasida sifatli ip ishlab chiqarish tasnifi	299
Bebutova N.N., Qiyomova S.I. Sanoat tarmoqlarida ekspluatatsiya talablarini hisobga olgan holda maxsus kiyimni takomillashtirish bo‘yicha tavsiyalar.....	303
Мухаммедова М.О. Научные основы выбора материалов для ортопедической обуви и внутренних стелек при повреждениях голеностопного сустава.....	310
Nazirov R.R., Abdurahmonov O.SH., Qurbonov A.B. 5LP rusumli linterga tajriba arra oraliq qistirmalarini tayyorlash va tajribalarning metodik uslublari	313
Мухаммедова М.О., Ахмедов Ж.Ж. Распределение биомеханических нагрузок в конструкции ортопедической обуви и их влияние на конструктивные элементы.....	317
Турдиев Б.Э., Росулов Р.Х., Очиллов М.М., Эрдонов А.М., Пардаев Б.Ч. Чигит элеватори учун лентали конвейерини ишлаб чиқаришдаги тажриба-синов натижалари.....	322
Узакова Л.П., Авезова А.А. Выбор материала для подкладки женской модельной обуви: требования, свойства, современные решения.....	326
Mardonov S.E., Muxtorova Z.N. Qatlamlarni biriktirish usulining ikki qatlamli to‘qimalarning fizik-mexanik xossalariga ta‘sirini aniqlash.....	331
Rayimberdiyeva D.X., Nabidjanova N.N. Tikuv sexlarida texnologik jarayonlarni loyihalashni takomillashtirish.....	335
Sharifbayev R.N., Obidov A.A. Pilla navlarini ajratuvchi adaptiv mexatronik tizim yaratish....	340
Ержанова Д.Ж., Мардонов С.Э. Инновационные подходы к проектированию трикотажных полотен с заданными эластическими свойствами для одежды сегмента 0–3 года	347
Ботиров А., Рахимов А., Шарипбаев Н. Использование ультразвуковой технологии для совершенствования процессов размотки коконов в шелковом производстве.....	351
Dehqonov G‘., Sharibayev N.Yu., Murodov R.S. Ipak qurtini parvarishlash texnologiyasi va qurtxonalarda mikroiklim sharoitlarini ta‘minlash masalalari.....	357

Ubaydova V.E., Abbosova M.O. Homilador ayollar uchun transformatsiyalanuvchi kiyim konstruksiyasini ishlab chiqish va uning funksional samaradorligini baholash.....	361
Rosulov R.X. Qoziqli barabanlarda qayishqoq elementlarni qo'llashni nazariy tadqiq qilish.....	370
Совутов М.Э., Мусаев Н.М., Ахмедов К.И., Мукимов М.М. Трикотаж тўқималари тузилиши ва калинлиги ўзгаришини иссиқлик сақлашда вақтга боғлиқлик ҳолатини назарий тадқиқи.....	373
Qodirova S.X., Abdullayeva G.Sh. Milliy naqshlarning arxitekturada qo'llanilishi va ularning qiyosiy tahlili.....	379
Sayidova M.X. Harakat energiyasidan quvvatlanuvchi aqlli isituvchi kombinezon..	384
Do'stova F.X. Turli navlardagi paxtalarni tozalashdagi mavjud texnologiyalar tahlili.....	387
ANIQ VA IJTIMOIIY-IQTISODIY FANLAR	
Fayazova D.S. Autizm bo'lgan talabalarning til o'rganishdagi xususiyatlari.....	392
Sharipova Sh.N. Oliy ta'lim tizimida raqamli texnologiyalar asosida texnik tafakkurni rivojlantirish usullari.....	395
Isxakov M.M. Axborot-kutubxona xizmati ko'rsatishda yangi innovatsiyalarni joriy qilish....	399
Sidiqova N.N. Ingliz va o'zbek tillarida milliy koloritni ifodalovchi frazeologik birliklarning lingvistik xususiyatlari.....	404
Саидова А.С. Таълим трансформацияси жараёнида бўлажак мутахассисларнинг касбий компетентлигини ривожлантириш методикаси.....	408
Hikmatov N.I. Innovatsion qurilish materiallari.....	412
Мухаммадов С.К., Илясов А.Т., Пахратдинов. А.А. Бухоро шаҳридаги “Абдуллахон” мадрасаси биносининг техник ҳолатини кучлантириш бўйича таҳлил ва тавсиялар.....	416
Tursunova N.N. Kasb-hunar ta'limi tizimida “Mehnat muhofazasi va xavfsizlik texnikasi” fanini o'qitishda zamonaviy ta'lim metodlarini qo'llash.....	420
Samadova R.A., Gafurova N.T., Xikmatov N.I. O'zbekistonning ijtimoiy-iqtisodiy siyosatida xotin - qizlarga oid insonparvarlik qarorlarining ahamiyati.....	426
Ортикова Г.Ш., Нурмухаммедова Б.И. Оценка состояния финансирования международной торговли в республике Узбекистан.....	430
Баракатова Д.А. Рус адабиётида танқидий реализм асосчиси.....	434
Мустақимова Қ.С. “Шоирлар одам атоси” ҳақида.....	437
Раупова М.Х. Динамические задачи в формулировке квадратичной неограниченной бинарной оптимизации (QUBO) и их квантовые решения.....	441
EKOLOGIYA VA ATROF MUHIT MUHOFAZASI	
Xolova Sh.A. Ecological efficiency of introducing “green technologies” into industry.....	447
Axmedova M.B. Maishiy qattiq chiqindilar asosidagi xomashyolardan ekologik toza va iqtisodiy samaradorligi yuqori mahsulotlar ishlab chiqarish.....	451
QUTLOV	
Фозилов Садриддин Файзуллаевич – 60 ёшда. Етук олим ва жонкуяр устоз.....	456

3. Rupesh J. Patil Comparison of performance analysis of Scheffler reflector and model formulation. 2011, pp.1335-1339 [Sheffler comparison of performance IJST.pdf](#)
4. Mohaymen Alutbi Thi Qar University. Linear Fresnel Reflector. June 2020. https://www.researchgate.net/publication/342163823_Linear_Fresnel_Reflector_LFR
5. Omer K. Ahmed, Sameer Algburi, Zaid H. Ali, Amer K. Ahmed, Hawazen N. Shubat Hybrid solar chimneys: A comprehensive review 2022, pp.438-460 https://www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf?utm_source=chatgpt.com
6. T.D. Jo'rayev. "Quyosh issiqlik va energetik qurilmalari" darslik 2022 y.
7. Safarov A.B., Juraqulov A.A., Qo'ziyev Z.E., Mamedov R.A., "Fokuslovchi quyosh kollektori", ixtiro patenti № IAP 7982 O'zbekiston Respublikasi Adliy vazirligi 11.03.2025 yil

Juraqulov Abdullo Xojaqulovich – "Elektr va energetika muhandisligi" kafedrasida tayanch doktoranti Buxoro davlat texnika universiteti Tel.: (+99891) 6349594, e-mail: juraqulovabdullo2@gmail.com

THE EFFECT OF DUST ACCUMULATION ON THE EFFICIENCY OF SOLAR PANELS AND METHODS FOR ITS DETECTION

Makhmudov M.I., Kushshayeva M.R., Nurov S.S., Timirov H.N., Sayfiyev H.O.

Bukhara state technical university.

Abstract. This article analyzes the scientific research of a number of World Scientists on methods of measuring and controlling the pollution of solar panels in order to reduce the energy deficit in our country and increase the efficiency of solar panels and produce environmentally friendly energy to the environment, their advantages and disadvantages.

Key words: solar panels, electrical energy, semiconductor, photodiode pollution, light absorption.

QUYOSH PANELLARI SAMARADORLIGIGA CHANGLANGANLIKNING TA'SIRI VA UNI ANIQLASH USULLARI

Maxmudov M.I., Qo'shshayeva M.R., Nurov S.S., Timirov H.N., Sayfiyev H.O.

Buxoro davlat texnika universiteti.

Annotatsiya. Maqolada mamlakatimizda energiya taqchilligini kamaytirish va quyosh panellarining samaradorligini oshirish hamda atrof-muhitga ekologik toza energiya ishlab chiqarish maqsadida bir qator dunyo olimlarning quyosh panellarining changlanganligini o'lchash va nazorat qilish usullari ustida olib borgan ilmiy tadqiqotlari, ularning afzalliklari va kamchiliklari tahlil qilingan.

Tayanch so'zlar: quyosh panellari, elektr energiya, yarim o'tkazgich, fotodiod changlanganlik, nur yutulishi.

Solar energy is a clean and unlimited renewable energy source that can be used to power homes, businesses, schools, hospitals, and other buildings. The advantage of solar panels is that they have a low environmental impact. Solar panels produce zero emissions; they are not like fossil fuels like coal or oil, which release carbon dioxide into the atmosphere. They are made of non-toxic materials like silicon and glass, so there is no risk of releasing harmful waste during the experimental process. Using solar energy has many benefits for the environment. Generating electricity from fossil fuels produces methane and CO₂ can lead to the production of harmful gases such as carbon dioxide, which leads to a decrease in air quality. To reduce harmful emissions from fossil fuels, it is necessary to use solar panels wherever possible. The more we use clean sources such as solar energy, the less pollution we can reduce in cities with high smog, reducing the amount of greenhouse gases in the atmosphere [1].

Solar photovoltaic technology has made significant progress in recent years and has become the preferred source of renewable energy. Currently, major research and development efforts are focused on improving efficiency and sustainable performance. However, a number of external factors that affect the performance of solar panels have a negative impact. Therefore, in order to

maximize the performance of the solar panel system, their performance must be constantly monitored and tested to optimize operation and maintenance procedures.

Solar panels, especially if they are rigid structures, require almost no daily maintenance. One of the main factors that requires the attention of users is the dust on the surface of the solar photovoltaic module. Due to the dust on the solar panels, the light efficiency is significantly reduced. Experiments have shown that one square meter of a uniformly distributed solar cell can reduce the power output by 40% due to the approximately 4 cubic centimeters of dust falling on it. Nowadays, the cause of dust on solar panels is caused by heavy traffic, construction work or agricultural activities.

Therefore, the main task is to identify the critical point at which solar panel contamination causes significant losses in electricity generation.

Methods for determining the contamination of solar panels. Method for comparing Volt-Ampere characteristics. A very simple method is to compare the actual current-voltage characteristic with the data obtained during the commissioning of the solar power plant. At the same time, it is strictly forbidden to use factory data, since they were obtained under almost ideal conditions. When commissioning a solar power plant, it is necessary to conduct a number of power tests - they will be very important for the subsequent assessment of the efficiency of the plant. Reliable and accurate measurement of solar radiation flux allows the collection of a database on the efficiency and performance of a solar power plant under various environmental conditions. This database is useful both in forecasting the amount of energy produced and in assessing the payback period of the project [2].

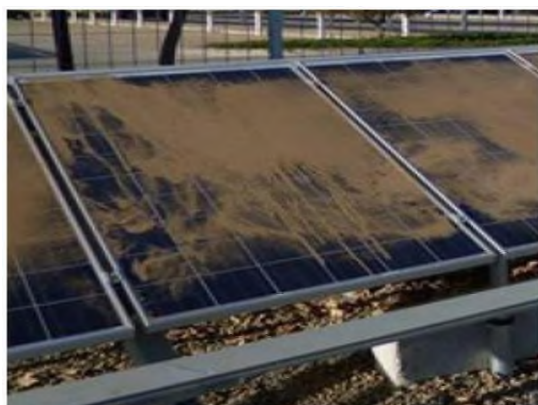


Figure 1. Solar panel state of pollution

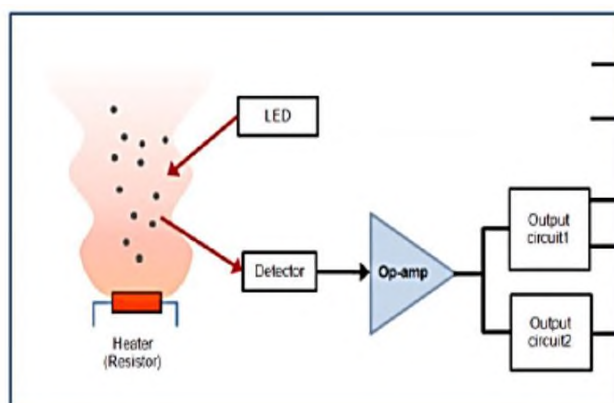


Figure 2. Principle of a dust measuring device scheme

The operating current of a solar panel can be calculated from the voltage curve. For example, the open circuit voltage and short circuit current of a solar panel are obtained from the parameters, while the power curve is obtained from the current and voltage values. The maximum power point is represented by the maximum delivered power point. The maximum power voltage and current are represented by the current and voltage at the maximum power point. From the above parameters, the device fill factor and conversion efficiency can be obtained as shown in Equations 1 and 2.

$$F.F = \frac{V_m I_m}{V_{oc} I_{sc}} \quad (1) \quad \eta = \frac{V_{oc} I_{sc} F.F}{A G} \cdot 100\% \quad (2)$$

Where A is the area of the panel and G is the irradiance incident on the panel surface. The performance of the panel under study is measured by the amount of energy it produces over time. In units kWh. Finally, the performance of the panel can be expressed in terms of the coefficient of efficiency. This is the energy produced normalized by the installed power, as shown in equation 3:

$$Y_s = \frac{E_{tot} t_a}{P_m} \quad (3)$$

It should be understood that the most accurate data for comparison can be obtained if they are obtained under baseline weather conditions. Since this is difficult to achieve in practice, data are usually recorded over several days to obtain average values, which are compared with baseline values recorded under similar weather and climatic conditions.

The main disadvantage of this method is that it does not take into account the aging of the modules or the failure of some of them, losses during conversion, the power supply from direct current to alternating current, etc. In addition, it is necessary to keep in mind the errors of the measuring instruments used, so the data obtained will have an error of $\pm 2\%$.

A tried and tested cleaning method. The control group of panels is based on comparing the results of electricity generation before and after washing. To do this, a group of panels is selected in the middle of the array or by taking individual panels in different places of the station. After obtaining the current-voltage characteristic, the panels are washed and repeated data are obtained under approximately the same weather conditions and at the same time. The results are compared and we can get information about the level of dustiness of the panels [3].

Solar panel control method. Continuous or periodic monitoring of the electricity production from a single solar cell is carried out. Reducing the production volume below a certain level requires investigation and a search for the causes of the decrease in efficiency, one of which may be dust. Method for determining dustiness using thermocouple pyranometers. Thermocouple pyranometers have a wide spectral sensitivity, so they are used to accurately measure the total solar flux incident on the surface of a photovoltaic panel. Thermocouples are the most commonly used temperature devices in temperature measurement. Their main characteristics are a wide measuring range, relatively stable performance, simple structure, good dynamic response, and the ability to remotely transmit 4-20 mA electrical signals.

The thermocouple sensor is reliably protected from external influences by one or two hemispherical solar covers. Modern inverters have an input for connecting a pyranometer, which allows you to measure the efficiency of the solar cell, which is specially connected to this inverter. To ensure measurement accuracy, the pyranometer must be installed in the same direction and at the same angle as the solar cell. Since thermocouple pyranometers have a flat and wide-spectrum sensitivity, they can accurately measure the entire solar flux density falling on the plane of the photovoltaic panel. The results obtained make it easy to draw conclusions about how efficiently the panel receives and processes the solar energy falling on its surface.

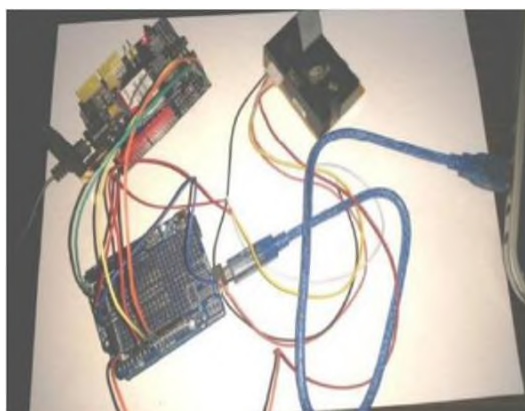


Figure 3. Dust measuring device, connection to microcontroller

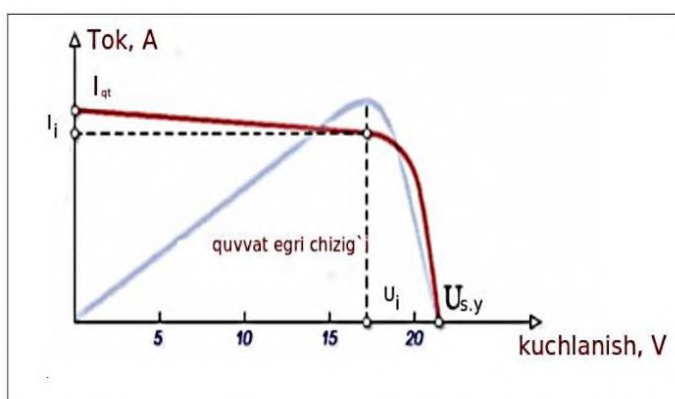


Figure 4. Solar panel voltage and current characteristic

SIM900 GSM/GPRS modem is used to connect to GSM network. This modem is responsible for sending SMS alert to power plant technician when dust storm occurs. The dust sensor used is DSM501A module, which is designed as compact size saving for particle density sensor. The working principle of this sensor is shown in figure [4].

Method for comparing current-voltage characteristics. The main element in photovoltaic systems is solar cells. Solar panels are made of various semiconductor materials. Solar radiation is absorbed by the structure of the semiconductor material, creating electron-hole pairs, which are then separated by the panel and collected on metal contacts on the front and back surfaces of the element. Photovoltaic modules are assembled from solar cells, and solar cells from modules. The data obtained during the operation of a solar power plant with several parameters at the same time are analyzed during operation. When starting a solar power plant, experiments are carried out on a number of energy. It is necessary to conduct tests - they will be very important for assessing the efficiency of the station.

This database is also useful for analyzing the amount of energy produced. Estimating the payback period of the project. Solar photovoltaic modules are recorded for several days to obtain average values that are compared with the data. The main indicators recorded under similar weather and climate conditions. Another important thing in measuring instruments is the error of the measuring instruments used, the data obtained will have an error of $\pm 5\%$.

Conclusion. It is impossible to imagine today's developing countries without electricity. Renewable and non-renewable energy sources are used. The use of renewable, that is, solar energy, is a rational solution. Other energy, unlike fossil fuels, solar energy is inexhaustible. Installing and using solar panels is a great solution for generating electricity and heat. However, factors that reduce the efficiency of solar panels include dust, snow, and bird droppings.

List of used literature

1. Chen Eugene Yu-Ta, Ma Lian, Yue Yuan, Guo Bing, Liang Hang, Measurement of dust sweeping force for cleaning solar panels, Solar Energy Materials and Solar Cells, Article in press. pp. 108-110.
2. Halbhavi S.B., Kulkarni S.G., Dr. Kulkarni D.B., Microcontroller Based Automatic Cleaning of Solar Panel International Journal of Latest Trends in Engineering and Technology (IJLTET), Vol. 5, Issue 4, pp. 99-103, 2015.
3. Zokirov S.I., & Obidjonov Z.O. (2018). Determining the optimal angle of installation of fixed-base solar panels. Scientific and practical conference of talented students, master's students, doctoral students and independent researchers. Republican scientific conference, Termez, pp. 205-207
4. Siddikov I.X., Sattarov H.A., Siddikov Q.I., Xojamatov X.E., Xasanov D.T., Olimova Sh.B., TDAT Publishing House. Textbook -T.; Modern energy conversion systems. 2018, 318 p.
5. Tina G.M., Grasso A.D., 2014. Remote monitoring system for stand-alone photovoltaic power plants: The case study of a PV-powered outdoor refrigerator. Energy Convers. That's it. 78, 862–871. <https://doi.org/10.1016/j.enconman.2013.08.065>.
6. Solnechnaya energetika v mire [Electronic resource]. URL:<https://alternativeenergy.ru/solnechnaya-energetika/92-solnechnaya-energetika-vmire.html>(data processing: 25.11.2019).

Makhmudov Makhsud Idrisovich - DSc, Professor, Bukhara State Technical University, Professor of the Department of Electrical and Power Engineering, +998 99 706 11 66

Kushshayeva Marguba Rustam kyzi - Bukhara State Technical University, basic doctoral student of the Department of Electrical and Power Engineering, +998 99 339 88 99 marguba.rustamovna22@gmail.com

Nurov Siroj Sobirovich - PhD, Bukhara State Technical University, Associate Professor of the Department of Electrical and Power Engineering, +99899 702 66 77

Timirov Husen Nusratillo oglu - Bukhara State Technical University, basic doctoral student of the Department of Electrical and Power Engineering, +998 97 853 30 30.

Sayfiyev Hasan Olim oglu - Bukhara State Technical University, basic doctoral student of the Department of Electrical and Power Engineering, +998 91 645 11 22