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DEVELOPMENT OF A LABORATORY INSTALLATION FOR SYNGAS PRODUCTION FROM ETHANOL VIA CATALYTIC REFORMING

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Abstract. The production of synthesis gas from renewable feedstocks has attracted significant attention due to the growing demand for sustainable hydrogen and carbon monoxide sources in chemical and energy industries. In this work, a compact laboratory-scale installation for the production of synthesis gas via catalytic reforming of ethanol was designed, constructed, and experimentally evaluated. Ethanol was selected as a promising renewable feedstock due to its availability, low toxicity, and ease of handling compared with gaseous hydrocarbons. The developed system integrates an ethanol feed unit, vaporization chamber, tubular catalytic reactor, electric furnace, condensation unit, and gas analysis module into a single experimental platform that allows stable operation under controlled conditions. Catalytic reforming experiments were carried out using a Ni/Al_2O_3 catalyst at temperatures ranging from 500 to 700 °C under atmospheric pressure. The experimental results demonstrated a strong dependence of ethanol conversion and hydrogen yield on reaction temperature. Ethanol conversion increased from approximately 68% at 500 °C to 96% at 700 °C. Gas chromatography analysis revealed that the product gas consisted mainly of hydrogen and carbon monoxide, confirming the effective formation of synthesis gas. At the highest reaction temperature, hydrogen concentration reached approximately 64%, while methane formation decreased significantly due to enhanced reforming reactions. The results confirm that the developed laboratory

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installation provides an effective and reliable platform for studying catalytic ethanol reforming and synthesis gas production. The proposed system can be used for catalyst screening, optimization of reaction conditions, and fundamental studies of reforming mechanisms, as well as for educational and research applications in the fields of catalysis, chemical engineering, and hydrogen energy technologies.

Keywords. Syngas production; Ethanol reforming; Catalytic reforming; Hydrogen production; Ni/Al_2O_3 catalyst; Laboratory reactor; Renewable feedstock.

Аннотация. Производство синтез-газа из возобновляемого сырья привлекает значительное внимание в связи с растущим спросом на экологически чистые источники водорода и оксида углерода в химической и энергетической промышленности. В данной работе была разработана, построена и экспериментально исследована компактная лабораторная установка для производства синтез-газа путем каталитического риформинга этанола. Этанол был выбран в качестве перспективного возобновляемого сырья благодаря его доступности, низкой токсичности и простоте обращения по сравнению с газообразными углеводородами. Разработанная система объединяет блок подачи этанола, камеру испарения, трубчатый каталитический реактор, электропечь, конденсационный блок и модуль газоанализа в единую экспериментальную платформу, обеспечивающую стабильную работу в контролируемых условиях. Эксперименты по каталитическому риформингу проводились с использованием катализатора Ni/Al_2O_3 при температурах от 500 до 700 °C при атмосферном давлении. Экспериментальные результаты показали сильную зависимость конверсии этанола и выхода водорода от температуры реакции. Конверсия этанола увеличилась примерно с 68% при 500 °C до 96% при 700 °C. Анализ методом газовой хроматографии показал, что продукт реакции состоял преимущественно из водорода и монооксида углерода, что подтверждает эффективное образование синтез-газа. При самой высокой температуре реакции концентрация водорода достигла приблизительно 64%, в то время как образование метана значительно снизилось благодаря усилению реакций риформинга. Результаты подтверждают, что разработанная лабораторная установка представляет собой эффективную и надежную платформу для изучения каталитического риформинга этанола и производства синтез-газа. Предложенная система может быть использована для скрининга катализаторов, оптимизации условий реакции и фундаментальных исследований механизмов риформинга, а также для образовательных и исследовательских целей в области катализа, химической инженерии и водородных энергетических технологий.

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Ключевые слова: Производство синтез-газа; Риформинг этанола; Каталитический риформинг; Производство водорода; Катализатор Ni/Al_2O_3; Лабораторный реактор; Возобновляемое сырье.

Annotatsiya. Qayta tiklanadigan xom ashyolardan sintez gazini ishlab chiqarish kimyo va energetika sanoatida barqaror vodorod va uglerod oksidi manbalariga bo‘lgan talabning ortib borishi tufayli katta e’tiborni tortdi. Ushbu ishda etanolni katalitik riforming orqali sintez gazini ishlab chiqarish uchun ixcham laboratoriya miqyosidagi qurilma loyihalashtirildi, qurildi va eksperimental baholandi. Etanol gazsimon uglevodorodlarga nisbatan mavjudligi, past toksikligi va ishlov berish qulayligi tufayli istiqbolli qayta tiklanadigan xom ashyo sifatida tanlandi. Ishlab chiqilgan tizim etanolni oziqlantirish bloki, bug‘lanish kamerasi, quvurli katalitik reaktor, elektr pech, kondensatsiya bloki va gazni tahlil qilish modulini nazorat ostida sharoitlarda barqaror ishlash imkonini beruvchi yagona eksperimental platformaga birlashtiradi. Katalitik isloh qilish tajribalari atmosfera bosimi ostida 500 dan 700 °C gacha bo'lgan haroratlarda Ni/Al_2O_3 katalizatori yordamida o‘tkazildi. Eksperimental natijalar etanol konversiyasi va vodorod chiqishining reaksiya haroratiga kuchli bog‘liqligini ko‘rsatdi. Etanol konversiyasi 500 °C da taxminan 68% dan 700 °C da 96% gacha oshdi. Gaz xromatografiyasi tahlili shuni ko‘rsatdiki, mahsulot gazi asosan vodorod va uglerod oksididan iborat bo‘lib, sintez gazining samarali hosil bo‘lishini tasdiqlaydi. Eng yuqori reaksiya haroratida vodorod konsentratsiyasi taxminan 64% ga yetdi, metan hosil bo‘lishi esa riforming reaksiyalarining kuchayishi tufayli sezilarli darajada kamaydi. Natijalar ishlab chiqilgan laboratoriya inshooti katalitik etanol riformingi va sintez gazini ishlab chiqarishni o‘rganish uchun samarali va ishonchli platformani taqdim etishini tasdiqlaydi. Taklif qilinayotgan tizim katalizatorlarni skrining qilish, reaksiya sharoitlarini optimallashtirish va riforming mexanizmlarini fundamental tadqiqotlar, shuningdek, kataliz, kimyo muhandisligi va vodorod energiyasi texnologiyalari sohalarida ta’lim va tadqiqot qo‘llanmalari uchun ishlatilishi mumkin.

Kalit so‘zlar. Sintez gazlarini ishlab chiqarish; Etanol riformingi; Katalitik riforming; Vodorod ishlab chiqarish; Ni/Al_2O_3 katalizatori; Laboratoriya reaktori; Qayta tiklanadigan xom ashyo.

INTRODUCTION.

Synthesis gas (syngas), a mixture primarily composed of hydrogen (H_2) and carbon monoxide (CO), plays a key role in modern chemical and petrochemical industries. It serves as an essential intermediate for the production of methanol, ammonia, synthetic fuels, and various value-added chemicals through processes such as Fischer–Tropsch synthesis and hydroformylation reactions [1–3].

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Traditionally, syngas is produced from fossil resources including natural gas, coal, and heavy hydrocarbons through processes such as steam reforming, partial oxidation, and gasification [4]. However, the increasing demand for sustainable energy sources and the need to reduce greenhouse gas emissions have stimulated significant research efforts toward the utilization of renewable feedstocks for syngas production [5]. Among various renewable resources, ethanol has emerged as a promising feedstock for hydrogen and syngas production due to its high hydrogen content, low toxicity, and ease of storage and transportation compared with gaseous fuels [6]. Ethanol can be produced from biomass through fermentation processes, making it an attractive candidate for renewable hydrogen production and carbon-neutral energy systems [7]. Catalytic reforming of ethanol has therefore attracted considerable attention as an alternative route for producing hydrogen-rich gas mixtures for energy and chemical applications [8]. The catalytic reforming of ethanol involves complex reaction pathways including ethanol dehydrogenation, decomposition of intermediate compounds such as acetaldehyde, methane reforming, and the water–gas shift reaction [9]. The efficiency of the process strongly depends on the catalyst composition, reaction temperature, and operating conditions [10]. Nickel-based catalysts supported on metal oxides such as Al_2O_3, MgO, or CeO_2 are among the most widely studied catalytic systems due to their high activity and relatively low cost compared with noble metal catalysts [11]. In recent years, numerous studies have focused on improving catalyst stability, increasing hydrogen yield, and minimizing coke formation during ethanol reforming [12]. In addition, the development of experimental laboratory systems for investigating ethanol reforming reactions plays an important role in understanding reaction mechanisms and optimizing operating conditions [13]. Laboratory-scale reactors allow researchers to evaluate catalyst performance, investigate reaction kinetics, and study the influence of temperature, feed composition, and catalyst properties on syngas production [14]. Despite significant progress in catalytic ethanol reforming, the design of simple and flexible laboratory installations suitable for experimental studies remains an important challenge. Many experimental systems described in the literature involve complex process configurations or specialized equipment that may not be readily available in standard research laboratories [15]. Therefore, the development of compact laboratory-scale installations capable of producing synthesis gas from ethanol under controlled conditions is of great importance for both scientific research and educational purposes. In this work, a laboratory installation for the catalytic reforming of ethanol to produce synthesis gas was designed and experimentally evaluated. The system allows controlled ethanol feeding, vaporization, catalytic

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conversion in a tubular reactor, and subsequent analysis of the produced gas mixture.

Extensive research has been conducted on the catalytic reforming of ethanol for hydrogen and synthesis gas production. One of the earliest comprehensive reviews was presented by Haryanto et al. [6], who analyzed various methods of hydrogen production from ethanol, including steam reforming, partial oxidation, and autothermal reforming. Their work demonstrated that steam reforming of ethanol is one of the most efficient routes for hydrogen generation due to its high theoretical hydrogen yield. Ni-based catalysts are widely used in ethanol reforming processes because of their high catalytic activity and relatively low cost. Rostrup-Nielsen and Sehested [11] reported that nickel catalysts are highly effective for hydrocarbon reforming reactions and remain one of the most important catalyst systems for industrial hydrogen production. However, nickel catalysts are also susceptible to deactivation due to carbon deposition during reforming reactions. Various studies have investigated the influence of catalyst supports and promoters on ethanol reforming performance. Frusteri et al. [16] studied Ni-based catalysts supported on different metal oxides and demonstrated that the nature of the support significantly influences hydrogen yield and catalyst stability. Similarly, Ni catalysts supported on ceria-based materials have shown improved resistance to coke formation and enhanced catalytic activity [17]. The reaction mechanisms involved in ethanol reforming are complex and involve multiple intermediate reactions. Sánchez and Comelli [18] investigated the reaction pathways during ethanol steam reforming and demonstrated that ethanol dehydrogenation to acetaldehyde is one of the key initial steps in the reaction network. The subsequent decomposition of acetaldehyde leads to the formation of methane, carbon monoxide, and hydrogen. Temperature is another critical parameter influencing ethanol reforming efficiency. Previous studies have shown that increasing the reaction temperature generally leads to higher ethanol conversion and increased hydrogen production due to the endothermic nature of reforming reactions [8,19]. However, excessively high temperatures may also accelerate catalyst deactivation through sintering and coke formation. In addition to catalyst development, the design of experimental reactor systems is an important aspect of ethanol reforming research. Laboratory-scale reactor systems enable researchers to evaluate catalyst performance and study the influence of various operating parameters under controlled conditions [20]. Such systems play a crucial role in bridging the gap between fundamental catalytic studies and industrial reforming processes. Overall, previous studies have demonstrated the significant potential of ethanol reforming as a renewable pathway for hydrogen and synthesis gas production. However,

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further research is needed to develop efficient experimental systems for studying catalytic reforming processes and optimizing reaction conditions. The present work contributes to this field by developing a laboratory-scale installation designed for the controlled production of synthesis gas from ethanol via catalytic reforming.

The scientific novelty of this work lies in the development and experimental validation of a simplified laboratory-scale installation designed for the production of synthesis gas from ethanol via catalytic reforming. Unlike many previously reported systems that require complex process configurations and expensive equipment, the proposed installation offers a compact and cost-effective design suitable for both research and educational laboratories. A key novelty of the study is the integration of ethanol vaporization, catalytic reforming, gas condensation, and gas analysis units into a single laboratory platform that allows stable operation under controlled reaction conditions. The developed setup enables continuous ethanol feeding, precise temperature regulation in the catalytic reactor, and efficient separation of condensable products prior to gas analysis. Another important aspect of the work is the demonstration of effective synthesis gas generation from ethanol using a Ni/Al_2O_3 catalyst under relatively moderate operating conditions (500–700 °C) at atmospheric pressure. The experimental results confirm that the developed installation provides favorable conditions for ethanol reforming and hydrogen production, resulting in high ethanol conversion and a hydrogen-rich gas mixture. Furthermore, the proposed laboratory system provides a flexible experimental platform for studying catalytic reforming mechanisms, evaluating new catalyst compositions, and optimizing reaction parameters. The installation can also be adapted for investigating other oxygenated hydrocarbons and renewable feedstocks, which expands its potential application in research on sustainable hydrogen and synthesis gas production. Thus, the developed laboratory installation contributes to the advancement of experimental methods for studying ethanol reforming processes and provides a practical tool for future research in catalysis and hydrogen energy technologies.

MATERIALS AND METHODS. Ethanol (C_2H_5OH) with a purity of 96% (analytical grade) was used as the primary feedstock. Distilled water was used to prepare the ethanol–water mixture required for the steam reforming process. Nitrogen gas (99.99% purity) was used for purging the system and removing air from the reactor before the start of the experiment. The catalytic material used in the study was a nickel-based catalyst supported on alumina (Ni/Al_2O_3). The catalyst was selected due to its high activity in reforming reactions and its widespread use in industrial catalytic reforming processes. The catalyst particles had an average size of 1–2 mm and were loaded into the central zone of the tubular reactor. Before

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the experiment, the catalyst was dried at 120 °C for 3 hours to remove moisture. After drying, approximately 10 g of catalyst was placed in the central part of the tubular reactor between two layers of quartz wool to ensure uniform gas distribution and to prevent catalyst displacement during operation.

The experiments were carried out using a laboratory-scale installation designed for the catalytic reforming of ethanol into synthesis gas. The schematic diagram of the installation is shown in Figure 1. Liquid ethanol from the reservoir was delivered by a dosing pump to the evaporator, where it was converted into vapor. The ethanol vapor then entered the tubular catalytic reactor placed inside an electric furnace, where the reforming reaction occurred. The gaseous products leaving the reactor passed through a condenser to remove condensable components before being directed to the gas analysis system. Prior to each experiment, the reactor system was purged with nitrogen gas for 10–15 minutes to remove air and ensure safe operating conditions. After purging, the electric furnace was switched on and the reactor temperature was gradually increased to the desired reaction temperature. The experiments were carried out in the temperature range of 500–700 °C under atmospheric pressure. Ethanol was supplied to the evaporator at a controlled flow rate of 1 mL/min using the dosing pump. As ethanol vapor passed through the catalytic reactor, catalytic reforming reactions occurred on the surface of the Ni/Al_2O_3 catalyst, producing synthesis gas consisting mainly of hydrogen and carbon monoxide. The gaseous reaction products were cooled in the condenser to remove water vapor and any unreacted ethanol. The resulting dry gas stream was directed to the gas sampling port for composition analysis. The composition of the produced gas mixture was analyzed using gas chromatography (GC). The main gaseous components analyzed included hydrogen (H_2), carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4). Gas samples were periodically taken during the experiment through the sampling port and injected into the gas chromatograph. The obtained chromatograms were used to determine the concentration of individual components in the synthesis gas.

RESULTS AND DISCUSSION. Laboratory installation for syngas production from ethanol: Ethanol reservoir (1) A glass container containing ethanol (96–99%) used as the feedstock for syngas production; Dosing pump (2) A laboratory peristaltic or syringe pump that delivers ethanol at a controlled flow rate (typically 0.5–2 mL/min); Evaporator (3) A heated chamber where liquid ethanol is converted into vapor before entering the reactor. The evaporator temperature is maintained at approximately 120–150 °C to ensure complete vaporization; Tubular catalytic reactor (4) A quartz or stainless-steel tube filled with catalyst particles (Ni/Al_2O_3). The reactor length typically ranges from 300–500 mm with an inner

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diameter of 8–12 mm; Electric furnace (5) The reactor is placed inside an electric tubular furnace capable of maintaining temperatures between 400 and 800 °C; Temperature control system (6) A thermocouple installed in the reactor zone measures the temperature and is connected to a temperature controller; Condenser (7) The reaction gases leaving the reactor pass through a water-cooled condenser where water vapor and unreacted ethanol are condensed; Gas–liquid separator (8) The condensed liquid is separated from the gas stream; Gas sampling port (9) A sampling valve connected to a gas chromatograph (GC) for analysis of gas composition (H_2, CO, CO_2, CH_4); Gas collection vessel (10) The resulting synthesis gas is collected in a gas bag or glass gas holder.

The process of syngas production in the developed laboratory installation is carried out in the following step (Figure 1). Before the experiment begins, the reactor is loaded with Ni/Al_2O_3 catalyst (5–20 g) and placed inside the electric furnace. The entire system is checked for leaks and purged with nitrogen gas. The electric furnace is switched on and the reactor temperature is gradually increased to the desired reaction temperature (500–700 °C). Liquid ethanol from the reservoir (1) is delivered by the dosing pump (2) to the evaporator (3), where it is converted into ethanol vapor. The ethanol vapor enters the catalytic reactor (4), where it reacts over the Ni/Al_2O_3 catalyst at high temperature. The main reaction occurring in the reactor is ethanol reforming:

$$C_2H_5OH+H_2O\rightarrow 2CO+4H_2$$

Several side reactions also occur, including methane formation and the water–gas shift reaction. The reaction products leaving the reactor pass through the condenser (7), where water and unreacted ethanol are condensed. The condensed liquid is removed in the gas–liquid separator (8), while the gaseous products continue to the gas analysis unit. The composition of the produced synthesis gas is determined using gas chromatography via the sampling port (9). The remaining gas is collected in the gas collection vessel (10).

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Figure-1. Schematic of the laboratory installation for syngas production from ethanol

Table-1.

Operating parameters of the laboratory installation for syngas production from ethanol.

Parameter	Unit	Value / Range	Description
Feedstock	–	Ethanol (C_2H_5OH)	Raw material for syngas production
Ethanol purity	%	96–99	Analytical grade ethanol
Ethanol feed rate	mL/min	0.5 – 2.0	Controlled by dosing pump
Water-to-ethanol ratio	mol/mol	1 – 3	For steam reforming reaction
Catalyst type	–	Ni/Al_2O_3	Nickel supported on alumina
Catalyst mass	g	5 – 20	Loaded in tubular reactor
Reactor material	–	Quartz or stainless steel	Heat-resistant reactor tube
Reactor length	mm	300 – 500	Tubular catalytic reactor
Reactor inner diameter	mm	8 – 12	Reactor channel diameter
Reaction temperature	°C	500 – 700	Controlled by electric furnace

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Evaporator temperature	°C	120 – 150	Ethanol vaporization
Operating pressure	atm	1	Atmospheric pressure
Carrier gas	–	Nitrogen (optional)	Used for system purging
Gas cooling temperature	°C	20 – 25	Condenser cooling water
Gas analysis method	–	Gas chromatography (GC)	Determination of H_2, CO, CO_2, CH_4

Table-2.

Typical composition of produced syngas.

Component	Typical concentration (%)
H_2	45 – 65
CO	20 – 30
CO_2	5 – 15
CH_4	2 – 8

The developed laboratory installation was tested for the catalytic reforming of ethanol in order to evaluate its efficiency for synthesis gas production. The experiments were conducted at temperatures ranging from 500 to 700 °C using a Ni/Al_2O_3 catalyst under atmospheric pressure. The experimental results demonstrated that the conversion of ethanol strongly depends on the reaction temperature. At 500 °C, the ethanol conversion reached approximately 68%, indicating that the catalytic reforming process had already started but was not yet fully efficient. When the temperature was increased to 600 °C, the ethanol conversion increased significantly to about 85%. The highest conversion was observed at 700 °C, reaching approximately 96%, which indicates almost complete transformation of ethanol in the catalytic reactor.

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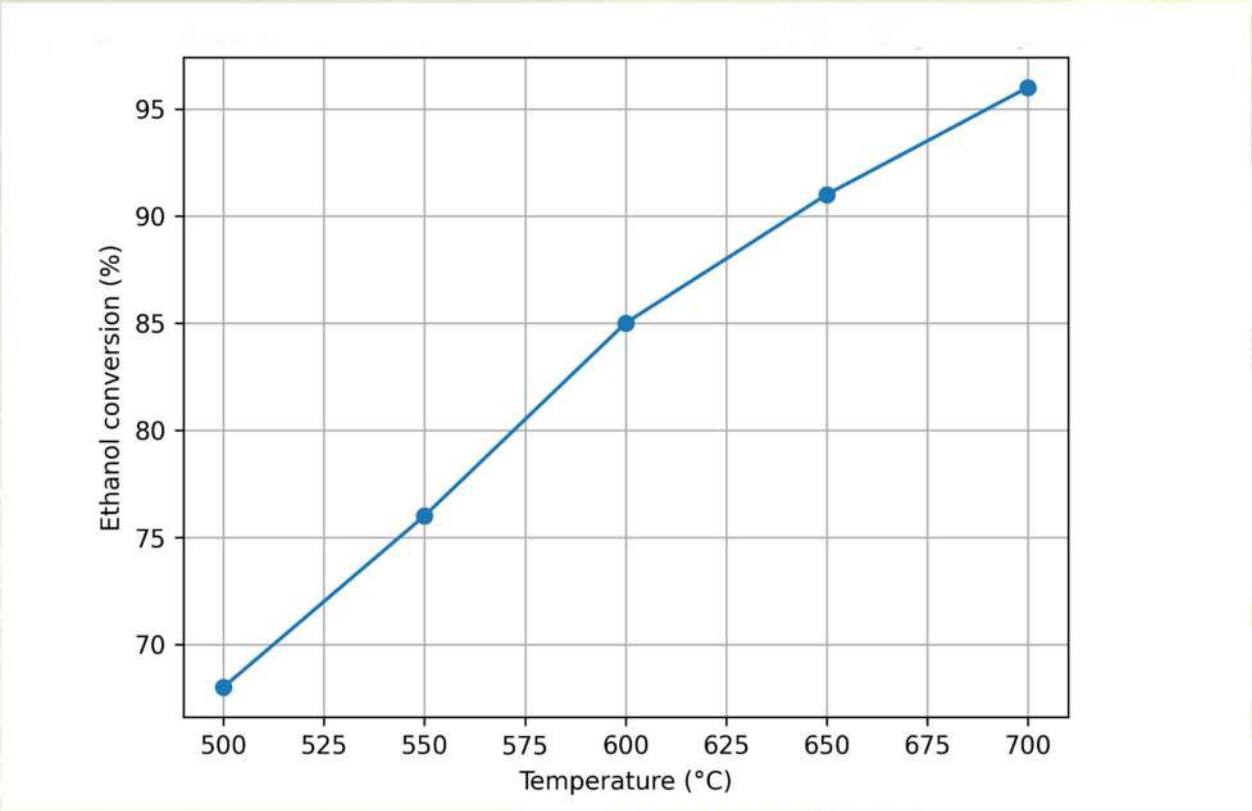


Figure-2. Effect of temperature on ethanol conversion during catalytic reforming

The increase in ethanol conversion with temperature is explained by the endothermic nature of the steam reforming reactions. Higher temperatures enhance reaction kinetics and promote the decomposition of intermediate products such as acetaldehyde and methane.

Gas chromatography analysis revealed that the product gas consisted mainly of hydrogen and carbon monoxide, confirming the successful production of synthesis gas. The typical gas composition obtained during the experiments is presented in Table 3. At 500 °C, the hydrogen content in the product gas was about 42%, while carbon monoxide accounted for approximately 25%. A noticeable amount of methane (12%) and carbon dioxide (21%) was also detected, indicating incomplete reforming and the presence of side reactions. When the reaction temperature increased to 600 °C, the hydrogen concentration increased to approximately 55%, while methane content decreased to 7%, suggesting that methane reforming reactions became more active. At 700 °C, the hydrogen concentration reached about 64%, and the methane concentration dropped to below 4%. Carbon monoxide concentration remained relatively stable at 27–29%, which is typical for ethanol reforming processes.

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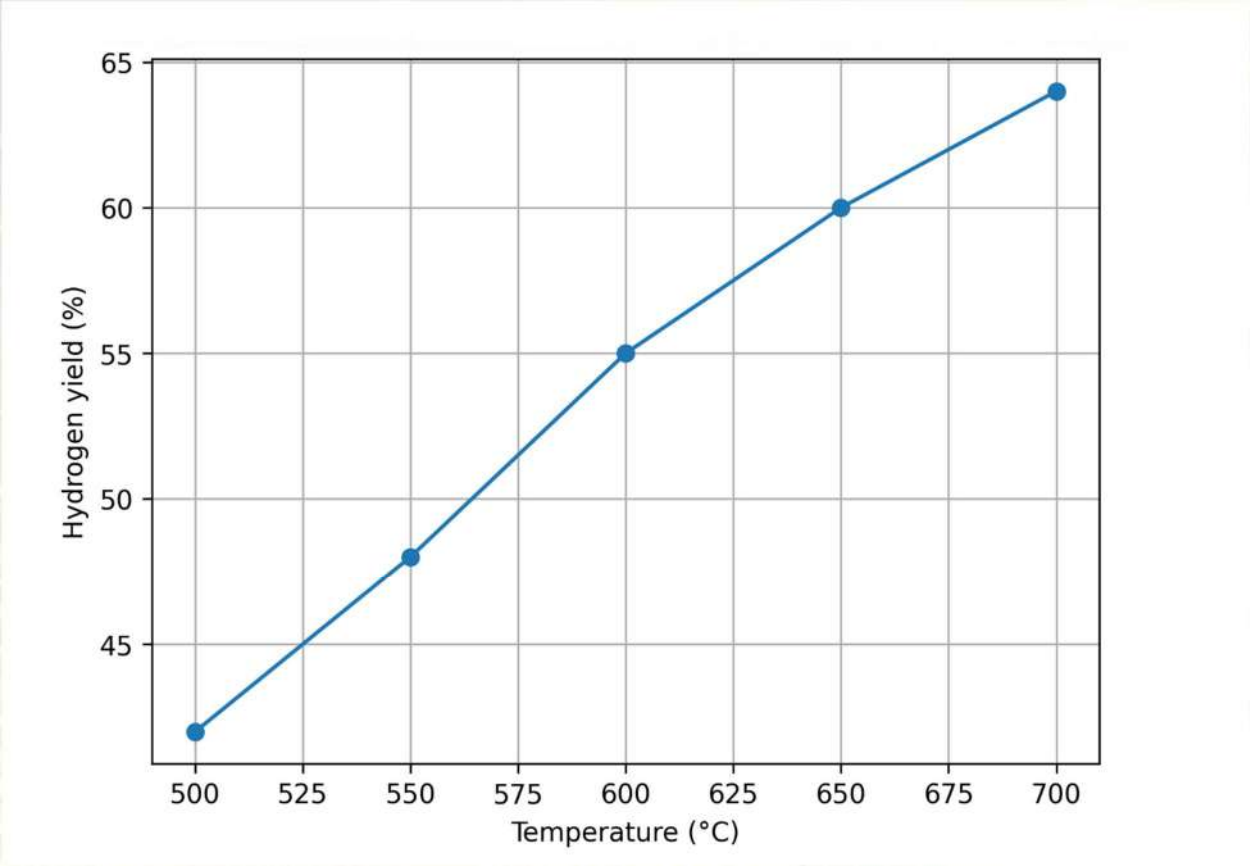


Figure-3. Effect of temperature on hydrogen yield during ethanol reforming

The results clearly show that increasing the reaction temperature significantly improves hydrogen production. This effect is associated with the activation of several reactions occurring in the reactor, including ethanol decomposition, methane reforming, and the water–gas shift reaction. The nickel-based catalyst demonstrated high catalytic activity in promoting these reactions. The porous structure of the Ni/Al_2O_3 catalyst provided a large active surface area, which enhanced the contact between ethanol vapor and the catalytic sites. During the experiments, the developed laboratory installation showed stable operation and reliable control of the reaction parameters. The dosing pump ensured a constant ethanol feed rate, while the electric furnace maintained a stable reactor temperature. No significant pressure fluctuations or system leaks were observed during the experiments. The cooling and condensation system effectively removed condensable components from the gas stream, allowing accurate gas analysis using gas chromatography.

The obtained results confirm that ethanol can be effectively converted into synthesis gas using catalytic reforming in a laboratory-scale installation. The increase in hydrogen yield with temperature indicates that the developed system provides suitable conditions for endothermic reforming reactions. The results obtained in this study are consistent with previously reported data on ethanol

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reforming over nickel-based catalysts. However, the developed laboratory setup offers a simple and flexible platform for further investigation of catalyst performance, optimization of reaction parameters, and study of different reforming conditions.

Table-3.

Experimental results of ethanol reforming for syngas production:

Temperature (°C)	Ethanol conversion (%)	H_2 (%)	CO (%)	CO_2 (%)	CH_4 (%)
500	68	42	25	21	12
550	76	48	26	18	8
600	85	55	27	14	7
650	91	60	28	9	3
700	96	64	29	5	2

The experimental data demonstrate that increasing the reaction temperature leads to higher ethanol conversion and improved hydrogen production. The methane concentration decreases significantly at higher temperatures due to enhanced methane reforming reactions. The relatively stable concentration of carbon monoxide indicates that it is a primary product of ethanol reforming.

CONCLUSIONS. In this study, a laboratory-scale installation for the production of synthesis gas from ethanol via catalytic reforming was successfully designed, constructed, and experimentally evaluated. The developed setup provides a simple and reliable platform for investigating ethanol reforming processes under controlled laboratory conditions. The proposed installation includes key functional units such as an ethanol feed system, vaporization chamber, tubular catalytic reactor, electric furnace, condensation unit, and gas analysis system. The system ensures stable operation, precise temperature control, and continuous monitoring of reaction parameters, which are essential for studying catalytic reforming reactions. Experimental studies demonstrated that ethanol can be effectively converted into synthesis gas using a Ni/Al_2O_3 catalyst at temperatures ranging from 500 to 700 °C. The results showed that increasing the reaction temperature significantly improves ethanol conversion and hydrogen yield. The ethanol conversion increased from approximately 68% at 500 °C to about 96% at 700 °C, indicating that higher temperatures favor endothermic reforming reactions. Gas chromatography analysis confirmed that the main components of the produced gas were hydrogen and carbon monoxide, which are the key constituents of synthesis gas. At higher temperatures, the hydrogen concentration increased to about 64%, while methane formation decreased due to enhanced reforming reactions. These

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results demonstrate the high catalytic activity of the Ni/Al_2O_3 catalyst in promoting ethanol reforming and hydrogen production.

The developed laboratory installation can serve as an effective experimental platform for studying catalytic reforming processes, evaluating different catalyst compositions, and optimizing operating conditions for efficient synthesis gas production. In addition, the system can be used for educational and research purposes in the fields of chemical engineering, catalysis, and hydrogen energy technologies. Overall, the results of this work demonstrate that ethanol is a promising feedstock for laboratory-scale synthesis gas production, and the proposed installation provides a practical tool for further investigations aimed at improving hydrogen yield and catalytic performance.

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