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**Barsha Sambyal**
Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

**Monica Reshi**
Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

**Neeraj Gupta**
Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

**Jesreen Chauhan**
Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

**Neeraj Sharma**
Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

**Bharat Sharma**
Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

**Manminder Pal Singh**
Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

**Gyan Singh Jankawat**
Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

**Corresponding Author:**
**Barsha Sambyal**
Division of Post-Harvest Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Jammu and Kashmir, India

# Waste to methanol: A review

**Barsha Sambyal, Monica Reshi, Neeraj Gupta, Jesreen Chauhan, Neeraj Sharma, Bharat Sharma, Manminder Pal Singh and Gyan Singh Jankawat**

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**Abstract**
Nowadays, waste management is a major concern for societies. Waste management is a problem that affects a wide range of businesses, including industry, services, and cities. As a result of substantial population increase, urbanization, and consumerism, the problem has gotten worse. This review paper comprehensively explores the technology in which a process architecture based on high-temperature gasification, syngas purification, and processing to methanol synthesis is used to transform waste and non-recyclable plastics into methanol. When methanol is produced using the Waste to Methanol process, greenhouse gas emissions are reduced by over 35% when methanol is produced using fossil fuels. Scientific efforts to identify potential uses for these materials were prompted by the increasingly stringent disposal regulations. As a result, numerous contributions to construction materials, energy production, agriculture, pollution control, and other critical processes were identified and developed.
But there are additional applications for these lignocelluloses' materials, and as science and technology develop, many more applications are anticipated in the future as societies place an increasing emphasisоn sustainability. Additionally, it is anticipated that many applications will be on a very modest scale, particularly when nations use rural development strategies to impede urbanization. Furthermore, the application of science may be constrained by non-scientific considerations, the fundamental idea of which relates to the economics of many processes. The final decisions about particular uses may ultimately come down to politics, either in the form of taxes or laws that favor one activity over another. It is also anticipated that some traditional uses, like burning straw, will eventually be phased out, leading to laws that encourage other uses.

**Keywords:** Waste to methanol, urbanization, municipal waste, syngas purification

## Introduction
The worldwide demand for energy has increased exponentially as a result of population grow th and changes in people's lifestyles brought about by technological advancements.
Fossil fuels, particularly natural gas and petroleum fuels, are the nonrenewable resources that power the majority of modern home and industrial activities since their stocks are finite and cannot be renewed throughout the course of a typical human lifetime. (Kumar *et al.*, 2019) [4]
Environmental contamination is another concern associated with their use. (Perera F. 2018) [6]
As a result, scientists are looking at a range of possibilities to develop substitutes for the impending energy problem. Manufacturing methanol from agricultural waste is one substitute Agricultural waste includes both the uncooked agro-waste and the biodegradable waste which can be utilized for the production of methanol.

## Mechanisms of methanol synthesis from agricultural waste
The main components of synthesis gas (syngas), which is produced by the different thermo chemical reactions mentioned above, are $H_2$ and CO, together with traces of $CO_2$ and other gases (Goransson *et al.*, 2011) [2]. Syngas has a variety of roles in the chemical sector. It is employed in a number of oil refining procedures as well as the synthesis of ammonia, methanol, and hydrogen. Nowadays, the majority of methanol consumed worldwide is created by reforming syngas derived from natural gas. However, a viable substitute for the manufacture of methanol is the development of several thermo chemical procedures such as pyrolysis and gasification are used in syngas generation projects that utilize biomass as fuel.

Depending on the catalytic conditions, hydrocarbons and alcohols are the two types of products formed during the catalytic conversion of syngas (Yang *et al.,* 2016) [11]. The syngas, comprising the substance in question contains carbon dioxide, carbon monoxide, and hydrogen. When catalyzed, it produces methanol and other by products such as acetone, methane, methyl formate, and higher alcohols. These higher alcohols include mixed alcohols, isopropyl alcohol, sec-butyl alcohol, tertiary butyl alcohol, and tertiary amyl ether. The general reaction for producing alcohol from syngas is as follows:

$$nCO + 2nH_2 \rightarrow C_nH_{(2n+1)}OH + (n-1)H_2O$$

For *n*=1, methanol is the primary product, while in order to make methanol from biomass, the syngas produced by its thermo-chemical conversion has to undergo further catalytic conversion has to undergo further catalytic conversion to form higher alcohols. Prior to producing methanol, syngas must be cleaned and the CO to $H_2$ ratio adjusted. Both low-pressure and high-pressure catalysts, such as $ZnO/Cr2O_3$, are used to convert syngas to methanol. Catalysts like Cu/ZnO and $Cu/ZnO/Al_2O_3$ are doped with alkali to enhance the synthesis of higher alcohols. When alkali-doped sulfides such as molybdenum sulfide and alkali-doped oxides such as $CuO/CoO/Al_2O_3$ are used, higher alcohols are produced. (Slaa *et al.,* 1992) [9].

Consequently, the catalyst's nature and the residence time in the reactor play a crucial role in Identifying the type of alcohol that has been developed. The synthesis of methanol from syngas is an exothermic process that requires a catalyst and high pressure, which is maintained at 300 bar and elevated temperatures (up to 200-400 °C) (Basu *et al.,* 2010) [1]. The high pressure and temperature create suitable operating conditions to sustain catalytic activity (Larocca *et al.,* 2010) [3]. However, thermodynamically, the reaction favors methanol production is best achieved in low-temperature, high-pressure environments since it is an exothermic substance. Although higher temperatures enhance catalyst activity, they diminish reaction specificity, leading to increased side product formation and reduced main product yield (Pisarenko *et al.,* 2007) [7]. The following represents the chemical processes that convert syngas to methanol:

$$CO+2H_2 \rightarrow CH_3OH$$
$$CO_2+3H_2 \rightarrow CH_3OH+H_2O$$

The ratio of $H_2$ to CO + $CO_2$ and the $CO_2$/CO ratio, respectively, have an impact on the reaction's ultimate yield and selectivity. Consequently, the removal of $CO_2$ is essential to increase both the selectivity and Methanol yield. The exothermic gas-phase catalytic process for methanol synthesis requires the syngas composition to be adjusted prior to this gas ratio requirement. The water-gas shift reaction occurs in the syngas during the manufacture of methanol, and it is essential to keep the $H_2$/CO ratio > 2/1 to promote reaction kinetics and regulate the creation of byproducts. (Molino *et al.,* 2018) [5] It is said that the water-gas shift reaction is:

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

Methanol production primarily relies on the reaction between CO and $H_2$, and the presence of carbon dioxide enhances this reaction. Ongoing efforts involve the development of two-phase catalytic reactors, employing unsupported catalysts or nano-particles supported on materials with large surface areas, including silica, carbon, or alumina. Furthermore, investigations on plasma-based methods for turning waste biomass into alcohol are now being conducted. Unfortunately, a major disadvantage of these methods is their high cost, which may be related to the requirement for costly metal catalysts and the necessity to operate at high pressures (5–20 MPa) and temperatures (200–900 ˚C) (Riaz *et al.*, 2013) [8]. Moreover, the requirement for extra cleaning procedures to further reduce gas emissions raises the overall cost. Thus, it's necessary to investigate alternate routes for manufacturing of methanol that can effectively save expenses. The biochemical route shows promise because it uses methane as a fuel for bacteria that are methanotrophic-bacteria that can convert methane to methanol at room temperature and pressure.

**Conclusion**

Because of its greater productivity, faster conversion rate, established infrastructure, and well-established technical understanding in existing conversion processes, the thermo-chemical conversion of waste biomass is particularly favorable. While these processes have proven despite being successful in producing notable quantities of methanol, important data about the right raw material conditioning, technical difficulties, unappealing economics, affordable catalysts based on biomass feedstock, and process variables like temperature, particle size, residence time, and yield are still lacking. Addressing these aspects is essential before scaling up these processes for commercial methanol production. At the laboratory scale, the generation of methanol via biochemical conversion methods has shown encouraging promise. However, achieving industrial-scale methanol production requires a strategic a blend of traditional methods and metabolic engineering techniques (Yadav *et al.,* 2018) [10].

**References**

1. Basu P. Biomass gasification and pyrolysis: practical design and theory. Academic press; c2010.
2. Goransson K, Soderlind U, He J, Zhang W. Review of syngas production via biomass DFBGs. Renew Sustain Energy Review. 2011;15:482-492.
3. Larocca V, Molino A, Petrone M, Barisano D, Giordano G, Braccio G. Synthesis of methanol from biomass-derived syngas: modelling and sizing of a bench-scale reactor. International Journal of Energy Technology and Policy. 2010;2:1-7.
4. Kumar R, Ghosh AK, Pal P. Synergy of biofuel production with waste remediation along with value-added co-products recovery through microalgae cultivation: a review of membrane-integrated green approach. Science of the Total Environment; c2019. p. 134-169.
5. Molino A, Larocca V, Chianese S, Musmarra D. Biofuels production by biomass gasification: a review. Energies. 2018;11:811.
6. Perera F. Pollution from fossil-fuel combustion is the leading environmental threat to global pediatric health

and equity: solutions exist. International journal of environmental research and public health. 2018;15:16.
7. Pisarenko E, Pisarenko V. Analysis and modeling of synthesis gas conversion to Methanol: new trends toward increasing methanol production profitability. Theoretical Foundations of Chemical Engineering. 2007;41:105-115.
8. Riaza Zahedi G, Klemes JJ. A review of cleaner production methods for the manufacture of methanol. Journal of Cleaner Production. 2013;57:19-37.
9. Slaa J, VanOmmen J, Ross J. The synthesis of higher alcohols using modified Cu/ZnO/Al2O3 catalysts. Catal Today. 1992;15:129-148.
10. Yadav S, Dubey SK. Cellulose degradation potential of *Paenibacillus lautus* strain BHU3 and its whole genome sequence. Bioresource Technology. 2018;262:124-131.
11. Yang L, Ge X. Biogas and syngas upgrading. In Advances in Bioenergy; c2016. p. 125-88.