

The most important thing for the manufacturers of materials and components is to know what the transformer manufacturers and users (utilities) expect of their products in the future



# Outlook for transformer materials and components

## Research-based insights into future trends

### Introduction

It is a common practice for manufacturers of materials and components to closely cooperate with transformer manufactur-

ers, some even with transformer users, all to lead the innovation in the right direction. An advantage of this type of cooperation is resolving a specific issue for

a specific customer, while on the other hand, such cooperation may result in focusing too much on a certain customer or a group of customers or creating a product

### ABSTRACT

The most important thing for the manufacturers of materials and components is to know what the transformer manufacturers and users (utilities) expect of their products in the future. Those expectations will

tomorrow be embedded in specifications with which those products will have to comply.

On the other hand, for transformer manufacturers and users, it is important to know what novelties they can expect from new materials and com-

ponents, because improved properties may be used to resolve certain pain points. The improved properties may be thermic, dielectric, and mechanical properties, better manufacturability, better compatibility with other materials, faster drying or impregnation, easier handling or installation, etc.



that will not have sufficient market relevance because it will probably resolve issues for a relatively small number of users.

Transformers Magazine has conducted Industry Navigator research of market and technology trends in 2021, with the goal to collect and analyse the expectations of a broader community. The article [1] discusses the results related to sustainability, while this article analyses the results related to expectations for materials and components.

### The research

In this research, we have collected 261 responses from different parts of the world. Having a sufficient number of responses coming from around the world provides a unique opportunity for various analyses, which enables obtaining reliable results and unbiased insights.

In this article, we will present and discuss results based on responses to questions related to transformer materials and

components from the Transformers Magazine's Industry Navigator research. All results are provided in the complete report [2], while a conference with in-depth discussion on the same subject is also available [3].

### Which bushing technologies will be the priority?

For bushing as a critical transformer component, it is important to compare expectations for available technologies. These are: plug-in bushings, completely dry bushings, bushings with oil-impregnated paper (OIP), resin-impregnated paper (RIP), and resin-impregnated synthetics (RIS).

There are overall results calculated based on all responses in the research, results of responses relating to medium power transformers<sup>1</sup> (MPT column), results of responses relating to dry-type transformers (dry column), and results provided by respondents from sub supplying companies<sup>2</sup> (manufacturers of transformer materials and components). For the sake of simplicity, here the results are represented by the rank, while in the report [2], there are also score results. The score

<sup>1</sup> In this research, transformers with rating 60–200 MVA are considered as medium power transformers

<sup>2</sup> Suppliers of transformer materials, components, and accessories

**For transformer manufacturers and users, it is important to know what novelties they can expect from new materials and components, because improved properties may be used to resolve certain pain points**

## A common conclusion regarding requirements for bushings is that the industry prefers dry and pluggable bushings

is calculated for each answer using a formula that takes into account the number of times the answer has been selected, and it provides more detailed differentiation of answer options. The rank is calculated according to the scores (the answer with the highest score has the ranking 1, the answer with the second highest score has the ranking 2, and so on).

In the Table 1, we can see that in the overall results ‘plug-in bushings’ are of the highest priority for respondents. On the second place, we have ‘RIP bushings’, and ‘RIS bushings’ hold the third place.

When we observe the responses related to medium power transformers, the order is a bit different, with ‘RIP bushings’ of the highest priority.

Responses related to dry-type transformers give the highest priority again

to plug-in bushings, while on the second place, we have ‘completely dry bushings’. This, of course, is not surprising, since we would naturally expect that requirements for different applications to be different, but having the exact ranking based on an extensive research helps a lot in understanding the differences, especially when you can also compare the scores of different answer options. Even if the ranking is just as we expected, having the confirmation is a valuable help.

When we take the responses provided by the sub-supplier, the first and second answers on the ranking list are the same as in the overall results, but on the third place we have ‘completely dry bushings’.

A common conclusion regarding requirements for bushings is that the industry prefers dry and pluggable bushings.

## Which tap-changer technologies will be the priority?

Tap-changer is another critical transformer component, and in the research, we have investigated the priority of available technologies: vacuum-type and dry-type tap-changers, solid-state (electronic) tap-changers, and tap-changers for distribution transformers.

In Table 2, we can see that ‘vacuum-type tap-changers’ are of the highest priority in all three columns that represent overall results, results which relate to power distribution applications and results for developed countries. On the second place, we have ‘dry-type tap-changers’, except for developed countries where we have ‘tap-changers for distribution transformers’. The need for voltage regulation in distribution transformers comes primarily because of distributed power generation (wind and solar power), which is used on a higher scale in developed countries, and on basis of this we can see that such result corresponds well with the reality, what gives an additional credibility to all obtained results.

Table 1. Priorities for different bushing technologies in different groups of responses

	Overall	MPT	Dry	Sub suppliers
	Rank	Rank	Rank	Rank
Plug-in bushings	1	2	1	1
Completely dry bushings	4	4	2	3
Solution for smaller transformers where bushings are not needed	6	6	6	6
OIP bushings	5	5	5	4
RIP bushings	2	1	3	2
RIS bushings	3	3	4	4

Table 2. Priorities for different tap-changer technologies in different groups of responses

	Overall	Power distribution	Developed countries
	Rank	Rank	Rank
Vacuum-type tap-changers	1	1	1
Dry-type tap-changers	2	2	3
Solid-state (electronic) tap-changers	3	4	4
Tap-changers for distribution transformers	4	3	2

**70 % of transformer manufacturers supports digital transformers. Is this a sign of their prosperous future?**

# Transformer components

- Q17: How likely is it that you would buy a transformer without the classic signal and control wiring, but with digital sensors and accessories that use digital communication?

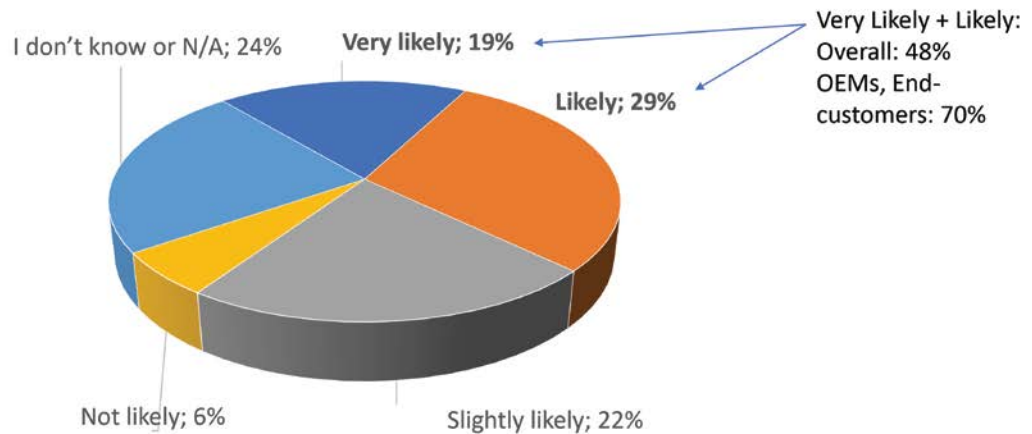


Figure 1. Overall results of likelihood of buying a transformer without the classic signal and control wiring

## Digital transformers

We have investigated the likelihood of buying a transformer without the classic signal and control wiring, but with digital sensors and accessories that use digital communication. Possible responses are: very likely, likely, slightly likely, not likely and I don't know or N/A<sup>3</sup>.

In such kind of questions, we analysed the percentage of 'Likely' and 'Very likely' answers, i.e., the sum of these percentages. From the Figure 1, we can see that the sum of 'Likely' and 'Very likely' answers in the overall results is 48%. This is already a solid share of respondents who would buy a 'digital' transformer. However, looking at the responses provided by transformer manufacturers, the sum of 'Likely' and 'Very likely' answers is 70%. Is such a strong support (70%) from transformer manufacturers to digital transformers a sign of their prosperous future?

## Transformer oil

We investigated different requirements and expectation for transformer oil, and apart from obtaining results we were able to compare the importance of biodegradability, oxidation stability, heat transfer and cooling, as well as safety.

<sup>3</sup> Not applicable

**A very important finding of the Industry Navigator research is the sequence of importance of key oil features: safety, heat transfer and cooling, oxidation stability, and biodegradability**

In the Table 3, we can see that rankings of importance for all four oil features are practically the same, i.e., ranking number one for all oil features is 'very important', number two is 'important', etc. However, the percentage of respondents who select each of importance category is different. For example, fire safety is 'very important' for 54.8% of respondents, while biodegradability is 'very important' for only 35.7% of them. Similarly, fire safety is 'not important' for only 3.6% of respondents, while biodegradability is 'not important' for 9.5% of them. In a similar manner, we can compare all responses for all four oil features. We also see that the share of 'I do not know or N/A' answers is practically the same for all four features, in it is at a level of about 15%. Finally, on basis of such observations, we can say that the sequence of oil features in terms of their importance would be (from the most important to the least important): safety, heat transfer and cooling, oxidation sta-

bility, and finally biodegradability. This is very important finding, as for example biodegradability is much more in the focus of discussions than heat transfer and cooling.

## Other questions regarding transformer materials and components

The Transformers Magazine's Industry Navigator research included some other questions regarding transformer materials and components, such as:

- Is voltage regulation necessary in distribution transformers?
- How likely is it that you would buy a transformer that processes data and controls cooling and voltage with the help of artificial intelligence?
- What needs to be offered for you to select re-refined insulating oils in your transformers?

Table 3. Comparison of importance of key oil features

	Biodegradability		Oxidation stability		Heat transfer		Fire safety	
	Pct.	Rank	Pct.	Rank	Pct.	Rank	Pct.	Rank
<b>Very important</b>	35.7 %	1	34.5 %	1	35.7 %	1	54.8 %	1
<b>Important</b>	25.0 %	2	28.6 %	2	33.3 %	2	22.6 %	2
<b>Slightly important</b>	14.3 %	3	13.1 %	3	15.5 %	3	6.0 %	3
<b>Not important</b>	9.5 %	4	7.1 %	4	2.4 %	4	3.6 %	4
<b>I don't know or N/A</b>	15.5 %		16.7 %		13.1 %		13.1 %	

- What will be the market share of non-mineral oil transformers in the next 5 years compared to the current share?
- Which materials that are used in transformers need to be improved?
- Which transformer components need to be improved?

Complete results, including a lot of analytics are discussed in TM's Industry Navigator conference [3], and are also available in TM's Industry Navigator report [2].

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**Complete results, including a lot of analytics are discussed in TM's Industry Navigator conference [3], and are also available in TM's Industry Navigator report [2]**

## Bibliography

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- [2] Dr. M. Banovic, A. Banovic, Transformers Magazine's Industry Navigator

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[3] Transformers Magazine's Industry Navigator Conference 2021, <https://transformers-magazine.com/conference-2021>, current: 20 March 2022



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