

Technical Note

Is the product fed properly when performing the auto-setting?

Metal detectors are being widely used on production lines from the process of raw material to final products to detect metal contaminants in food, pharmaceutical, industrial products, etc. To keep the standards for food safety, product quality managers are required to perform the sensitivity settings correctly when using the metal detectors. When setting the sensitivity of a new product, the auto-setting (*) is usually performed; however, there are some cases where important points for performing the correct setting are overlooked.

*Auto-setting:

By feeding the product ten times, the machine itself can measure the effect of the product in the magnetic field, and determine the reference value of a PASS product. Anritsu metal detectors automatically set the NG evaluation value five times the reference value as the initial value of the detection limit.

As a result of this, we have received inquiries from our customers who are using our metal detectors, such as "the sensitivity cannot be met in-house standards", and "there are frequent false rejects occur on site". In this paper, we will explain the correct way of feeding the product when performing the auto-setting. By identifying the cause of the problem, proper measures can be taken.

Review

First, let's start with the review of the basic principle of metal detectors. A metal detector generates a magnetic field in its detection head (a sensor having a shape of tunnel) and monitors a change in a magnetic field when a product passes it through. When the signal exceeds the set value (threshold), it evaluates the change as a metal contamination.

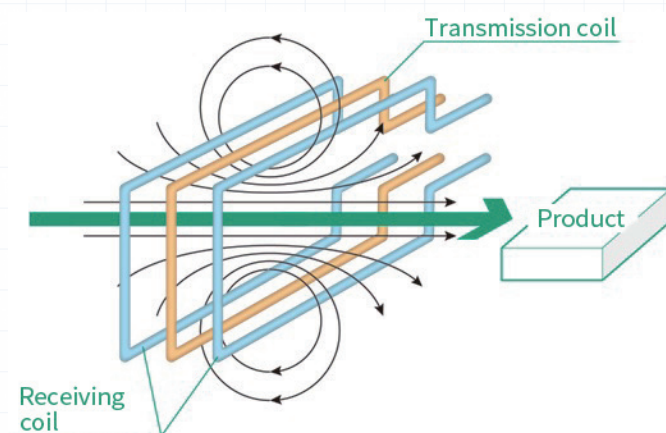
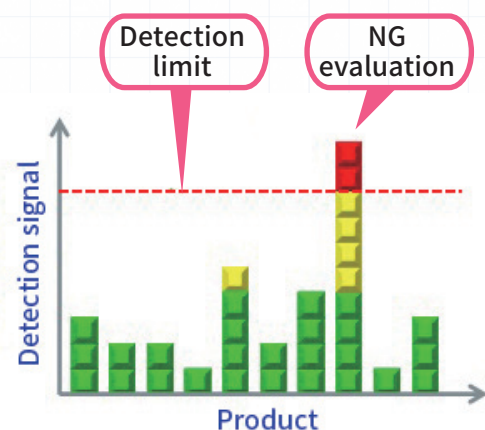
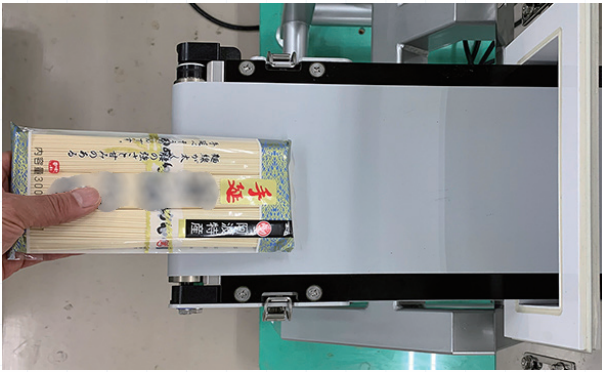


Image of magnetic field of metal detector

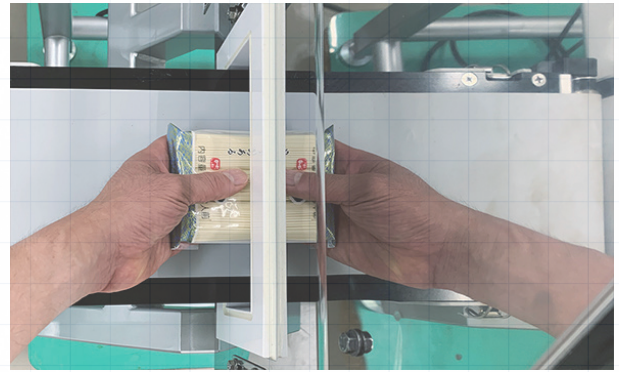


Detection limit (threshold)

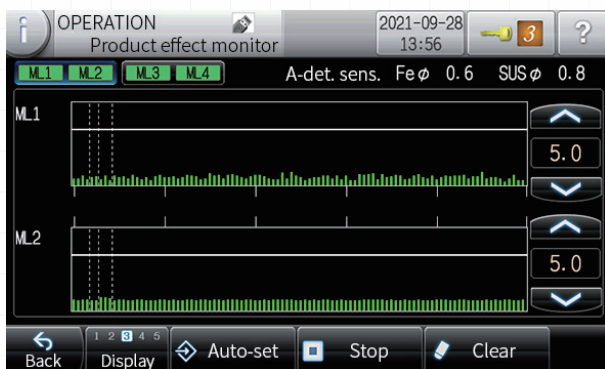
Here, we are going to show you the experiment. When setting the sensitivity, feed the product from very close to the detection head as shown in the following image.



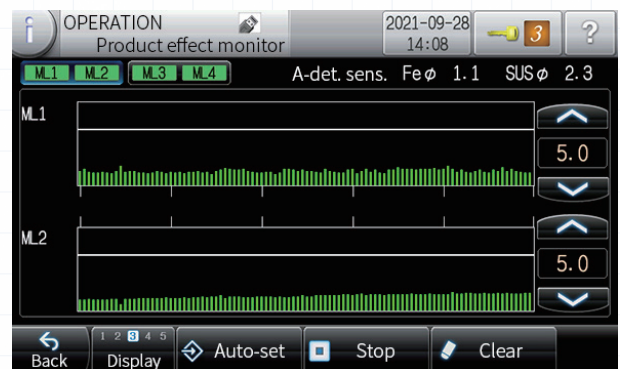
When feeding from the end of the conveyor



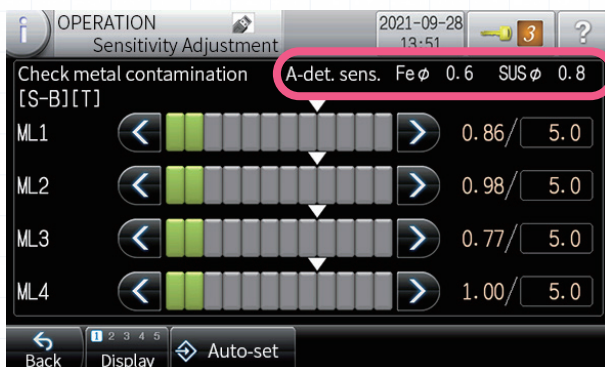
When feeding with hands



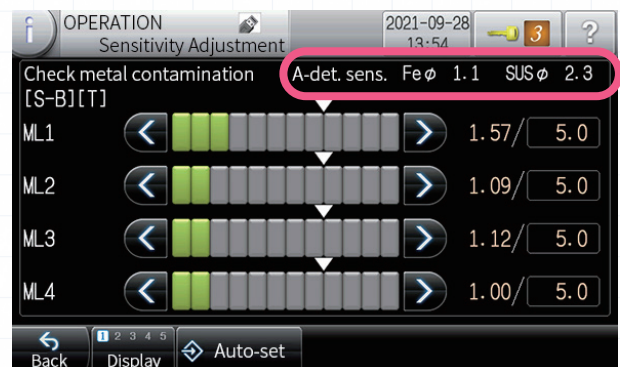
Product effect value



Product effect value
(feeding with hands will have a larger impact)



Estimated detection sensitivity



Increase in the estimated detection sensitivity

A human hand is not considered as metal contaminant; however, the human body contains a large amount of water, salt, and iron (blood), which affects the magnetic field and the product effect value can change greatly just like the product to be inspected. When this effect value is adopted as reference, the detection limit (threshold) for evaluating a PASS and a defective product is set much higher than it should be, which means that a test piece in the expected size cannot be detected. When setting the product by feeding from the end of the conveyor, the estimated detection sensitivity is 0.6 diameter for Fe and 0.8 diameter for SUS. However, when feeding with hands, it will be 1.1 diameter for Fe and 2.3 diameter for SUS, showing a clear difference in detection sensitivity. This is because the product effect value that determines the detection limit is different.

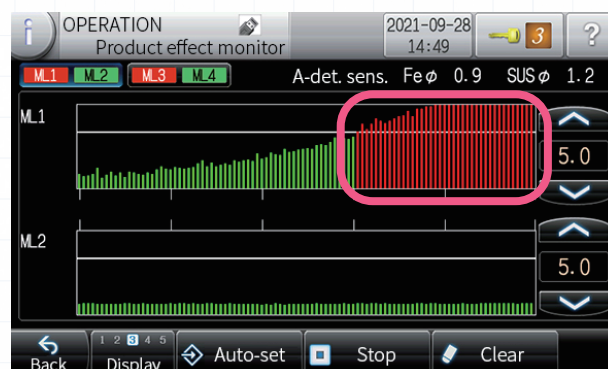
The above is a very simple example. In the next section, we will show you an example of a case where the product effect is significant without any notice.

Carelessness in setting sensitivity (1) - Condensation in frozen product -

This is a case that we frequently receive inquiry about frozen food products. While the sensitivity is being set, the product temperature rises due to the influence of room temperature and the body temperature of the hand, causing condensation to the product (water droplets adhere to the surface of the package). Similarly, water in food changes from ice to water, but water is more electrically conductive than ice and has a greater effect on magnetic fields. Even if the operator tries to set the sensitivity in a condensed state, the ideal detection sensitivity cannot be achieved. This is because the product effect is large and the detection limit (threshold) inevitably rises.



Frozen loose meat

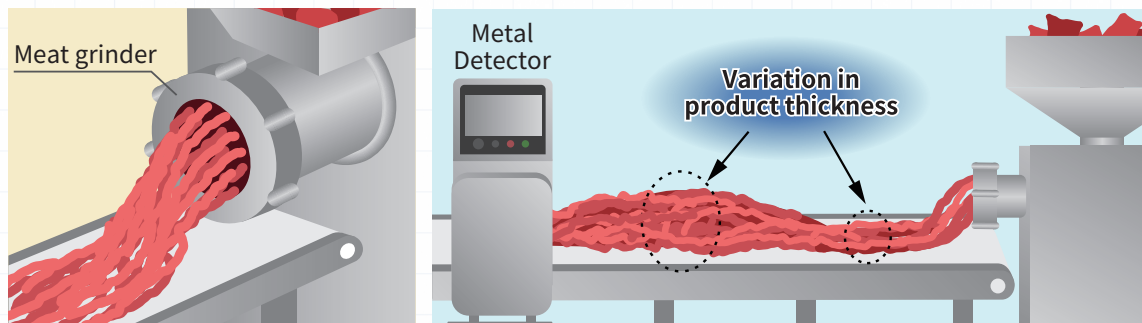


Product effect increases as condensation increases

Carelessness in setting sensitivity (2) - Uneven inner contents of the product to be inspected -

What kind of product samples do you use when registering a unpackaged product? In many cases, you use the bulk flow product by putting it in a plastic bag with a zipper for product registration. When setting the detection sensitivity, it is important to use a sample product considering variation in the actual production line. This enables the operator to perform the setting properly, reduce false rejections after the start of production and improve the production yield.

We take bulk flow ground meat as an example of unpackaged products. When block meat is put into a meat grinder machine, it is pushed out into a ground shape and placed on a conveyor. Immediately after the meat grinder is activated, the amount extruded tends to be larger and then gradually get smaller. Also, the amount extruded varies depending on the difference between the lean and fat content of the meat. The thickness of ground meat conveyed continuously on the conveyor to the next process varies and the product effect is changeable.



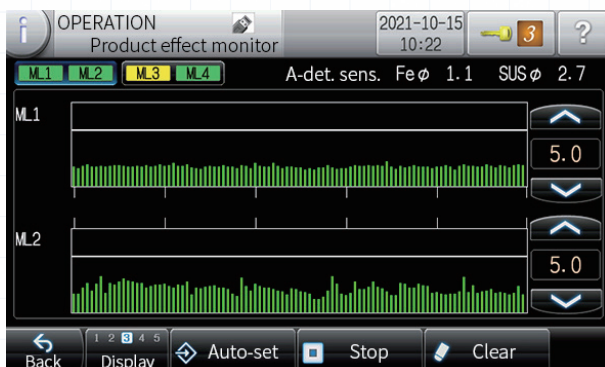
To show the difference in the product effect, we put ground pork in a plastic bag with zippers and perform an experiment. The sample product 1 has a larger content with more thickness. In contrast, the sample product 2 is filled with the normal amount.



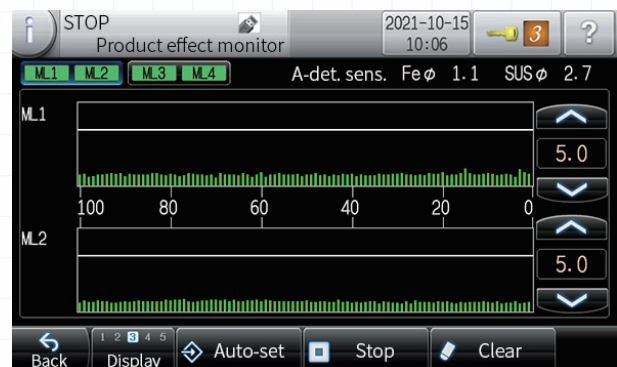
1. With product thickness in large



2. With product thickness in small



Product effect when product thickness is large

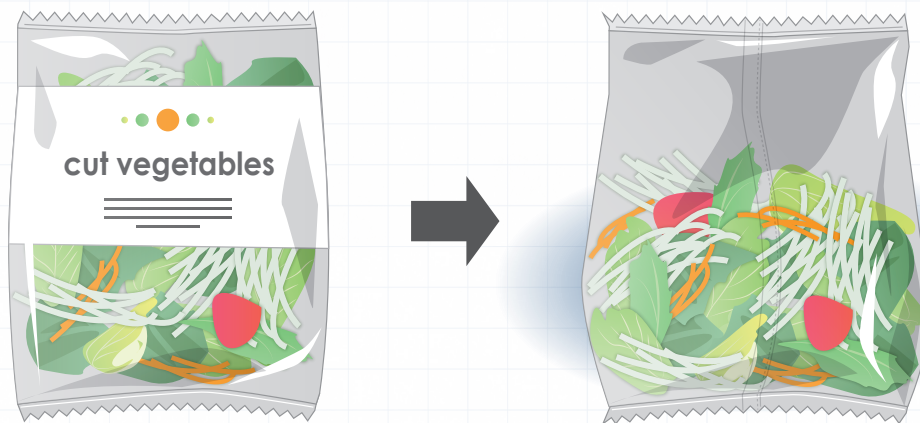


Product effect when product thickness is small

You can see the difference in the product effect. In the auto-settings, the detection limit (threshold) is determined by multiplying the product effect value by a certain magnification. Therefore, you can intuitively understand that the detection limit for the sample product 1 becomes larger than the detection limit for the sample product 2.

If the sample product 1 is fed through the metal detector at the detection limit set in the sample product 2, the metal detector will evaluate it as an NG (a defective product). On the production line, as described above, the product to be inspected is fed in a state where the flow rate is not consistent, so false rejection can occur frequently in the setting for the sample product 2. It is required to set the limit with a margin rather than aiming at the best possible sensitivity. However, the detection sensitivity is also important, so let's try some products with varied thickness to know the proper way of performing the auto setting.

The uneven inner contents can occur to products in vertical pillow packaging. A vertical pillow packaging machine is installed directly under the automatic combination weigher and when the contents are dropped from the top to the bag, the bottom of the product can swollen inevitably.



When setting the detection sensitivity, it needs to use a sample product with its contents swelling toward the bottom. If the sensitivity setting is performed while the thickness of the sample is leveled by hand, the deviation is alleviated and the product influence value is also lowered, so that the detection limit (threshold) is registered without any margin. If there is no margin, false positives often occur at the time of sensitivity check before production starts or after production starts.

If high sensitivity detection is required on the production line, place workers, install rollers, etc., to equalize the unevenness of the product to be inspected before entering the metal detector. In this case, the auto-setting needs to be performed with a product having uniform thickness to lower the detection limit.

Carelessness in setting sensitivity (3) - Do not misuse similar settings -

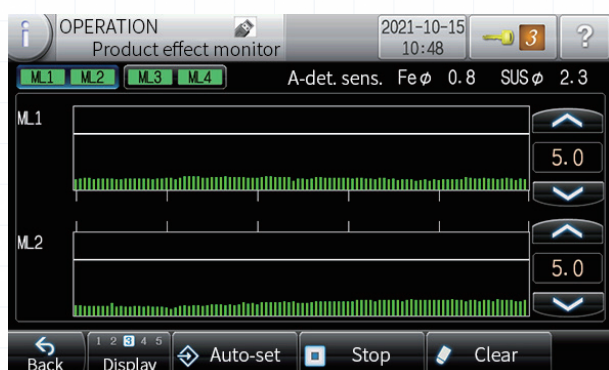
Do you tend to copy the setting of a similar product because the appearance of the product is the same or the product is the same type with different content? We will explain using a side dish (potato salad) as an example. For example, if the amount of content is increased in a campaign for a limited period such as "The amount is up 30%", the amount of salt and water contained in the product becomes large, so the detection limit for regular products often causes false detection during sensitivity check before production or after starting the production.



Potato salad in normal value



Potato salad with the 30% increase



Product effect in normal weight



Product effect in the increased weight

You can see that the difference in effect values is larger than you imagined. When handling the same side dishes with variation, please set the sensitivity as a different product. The same thing can happen when you change the amount of salt and the strength of taste depending on the season.

Conclusion

This paper explained common carelessness on how to feed the product when setting the sensitivity of the metal detector. For the same reason, there is a possibility that "the test piece cannot be detected" or "a PASS product is evaluated as an NG product" occurs when checking the sensitivity at the production site before starting the production. On production lines where there is not a lot of turnover and sensitivity setting is carried out infrequently for several months, quality managers may forget the procedures. If NG occurs frequently on the production line, it will lead to an increase in the time and effort for re-inspection and the disposal of products. Please refer to this technical note and set the appropriate sensitivity to prevent troubles.

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