Rijk Zwaan @ Physics with Industry 2020

The high need for a method to measure water potential continuously in seed priming.

1. Company information

Rijk Zwaan is a plant breeding company. We develop new vegetable varieties and sell the seeds produced from them all over the world. We are part of the food production chain and we are involved in helping feeding the growing world population. Rijk Zwaan is a family owned company and has around 3,300 highly motivated employees in 30 different countries. Rijk Zwaan is the no. 4 vegetable breeding company in the world with an annual turnover of over 450 million euro. In order to develop new varieties and supply top-quality seeds, continuous innovation is essential. Forty percent of our colleagues are actively involved in research and development, and we invest around 30 percent of our turnover in R&D each year.

2. Problem

Our seeds need to have a very high quality. This means that the seeds should develop in a good and healthy seedling and germinate quick and uniform over a broad temperature range. For many crops, seeds are not able to reach these last two demands without a treatment called seed priming. This priming treatment consists of the following steps:

- Seeds are wetted with water to a desired level.
- These wetted seeds are brought to a climate-controlled environment for a specific period and temperature.
- Thereafter, the process is stopped by drying the seeds back to their original moisture content.

With this priming treatment, we realize that a part of the germination process in the seeds is started. Due to this treatment, seed quality is improved because they germinate faster and more uniform.

Priming is a highly controlled process and is dependent on several factors like seed-water relations, temperature, oxygen and duration. One of the most critical parameters in the priming is the seed-water relation. Therefore, much effort is put in optimising and controlling this parameter. Non-optimal or deviating seed-water relations will lead to over- or underprimed seeds. Quality demands from the market become higher and thus there is a need to have a continuous high quality process control to further optimize priming.

The level of seed-water relations is indicated by the seed-water potential (WP, MPa). A big obstacle is that there is no method to measure seed-water potential accurately and constantly during a priming process. Most methods measure parameters that are linked to WP but these are empirical derivatives and/or are often offline (e.g. Decagon WP4C chilled mirror technique). This means that we have to take samples and thus disturb the process and therewith the seed-water equilibrium. Moreover we do not have a continuous measurement but only some indicative measurement points. Therefore, we want to develop a method which can continuously, non-destructively measure seed-water potential with a high accuracy during the priming process. It is known that the seed-water potential of the seeds is in equilibrium with the water potential of the medium surrounding the seeds. In our situation this medium is air. Therefore, a method that can continuously, non- destructively measure the water potential of air is a good solution.

The industry standard to measure WP offline is a chilled mirror dew point meter which accurately measures the dewpoint of the surrounding air of the sample, having an accuracy of 0,1MPa, being 0,05% RH. The developed meter should at least match these criteria:

- Measure accurately at +/-0,1 MPa
- Measuring in a range of +1 to +40 C at ambient pressure.
- Stable measurement given small fluctuations in temperature (+/-0,5 C) and pressure (+/-50 Pa) .
- Should be able to do this continuously in a closed vessel of about 20L, on a drumpriming machine.
- Reach a stable measurement within one hour, e.g. tensiometers usually are too slow.
- Should not disturb the relation between water and seed, another drawback of tensiometers.
- Costs should not exceed €10.000,-/measurement device.

We need help to select the right physical quantity and technique to measure accurately, given the above described circumstances. This can be an existing technique which needs to be slightly adapted or a newly developed technique. We expect at least thermodynamics, biophysics and chemical physics to be relevant, but e.g. optics might be possible as well, depending on the chosen quantity and technique for the measurement. As far as we know there is no device yet to measure water potential inline.