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The EZ-2 Elite

The latest model in the popular EZ-2 range was recently announced, extending the capability of the EZ-2 considerably.

Here we take a look at just what this new family member is capable of.

The Journey so far

First, a quick recap.

It's 10 years since Genevac launched the EZ-2 range at the Analytica show. It represented a breakthrough in evaporation convenience, offering

- a compact all in one benchtop system
- easy selection of effective solvent specific evaporation methods with no programming
- easy to use automatic end of run detection that had until then only been available on the very latest high end HT systems
- sample temperature protection but without the need for temperature probes which users of high performance HT systems had to use
- all the intelligent control of pressure and multi stage methods that Genevac had developed for the high performance HT systems, but without the need for user programming, resulting in optimal evaporation speed, solvent recovery and bumping prevention.

The EZ-2's size addressed the need for a smaller local evaporator in the lab rather than a large core facility somewhere on the same floor.

It initially offered a fixed number of methods plus one "spare" position on the dial. This was so that in certain cases a new method could be developed in the Genevac R&D department and rolled out to a subset of users with a particular common need. The first actual instance of this was a "very low boiling point" program for improved solvent recovery of solvents such as hexane. This later went on to become a standard available method on later models.

There were of course limitations. The EZ-2 Plus's PTFE diaphragm pump (though robust and compatible with a very wide range of solvents) limited the level of vacuum that would ever be available which in turn limited the highest boiling point solvent that could be removed. DMF & dimethylacetamide represented the top end of what was effectively possible, and lyophilisation was not possible.

Along the way there have been various new features added. HCl resistance, the SpeedTrap™ "coffee pot" style cold trap which allowed the user to easily transport captured solvent away, the Envi system with methods specifically tailored to concentration of analytical samples. The fixed multi position method dial was replaced with a potentially unlimited list of onscreen methods, expanding the range of scenarios which the system could be programmed to tackle as standard.

But certain questions just keep cropping up

- "Can it do DMSO ?"
- "Can it do Lyophilisation ?"

Enter the Elite

The newest EZ-2 system addresses many of the requests raised along the way. Some of the new features are quite obvious and their application is clear, whereas some are more subtle.

"It's got a scroll pump !"

Perhaps the most obvious thing about the Elite is the external scroll pump. This enables it to achieve vacuum levels comparable with the high performance HT systems Genevac have offered for many years.

Usually the statement above is swiftly followed by "so can it do DMSO ?".

The Elite can indeed remove DMSO.

After a few moments reflection, the next question may be "can it lyophilise as well ?".

In fact lyophilisation requires more than just a high level of vacuum. But as described below, the Elite has what is needed for that as well.

Lyophilisation

If all samples consisted of simply water and some dissolved compound, then adding lyophilisation capability would only require adding a pump capable of achieving sufficient level of vacuum (to get the BP of water well below it's freezing point).

But in reality, the vast majority of users who want to lyophilise are actually starting with HPLC fraction consisting of both an aqueous and an organic phase. And to successfully deal with this task, a system needs something else besides a good level of vacuum.

Lyophilisation without pre-frozen samples, in a non refrigerated system, requires the use of vacuum to control sample freezing. It is not realistically possible to freeze a water/acetonitrile mixture, but what is possible is to remove the acetonitrile by conventional evaporation means and **then** lyophilise the water away.

And this is where the challenge lies. Once the acetonitrile has been removed and captured in the condenser, it is then difficult to pull the required level of vacuum on the main chamber because the acetonitrile in the condenser "spoils" the vacuum. Because the cold trap is connected to chamber, pulling a vacuum on the chamber means pulling a vacuum on the cold trap, which drops the boiling point of whatever solvent is in it. When the boiling point of the solvent gets down to the temperature of the cold trap, (at between 1 and 3 mbar, for acetonitrile, depending on how cold the trap is) the trap is now warm enough to boil the solvent. As the pump tries to lower the pressure in the chamber further, it just ends up pumping large quantities of solvent out of the trap as vapour. Until the trap is empty, the vacuum seems stuck at that level (and those who haven't seen this phenomenon sometimes conclude there is a leak or the pump is faulty!)

So the answer is to be able to remove the acetonitrile from the trap before attempting to lyophilise the water. That way the pump can be allowed to get the chamber down to the level of vacuum that is required.

Emptying the trap is easy enough to do manually (if you happen to be there just at the right time) but as it could happen halfway through the evening it is preferable to automate it.

Auto Draining Condenser

The EZ-2 Elite solves this problem with a condenser that can drain automatically under control of the programmed method.

And with this feature, the EZ-2 Elite is able to offer lyophilisation of HPLC fractions, with no pre-freezing.

But it's not just lyophilisation of fractions that benefits from an auto draining condenser. Mixtures of high and low BP solvents (for example methanol and DMSO, or DCM and DMF) would be impossible to remove in a single run without the condenser being drained partway through.

And there are other, more subtle benefits.

There are some solvent mixtures which *can* be removed without auto draining, but with auto draining the solvent recovery is better. This is because when the least volatile of the solvents are being removed, the vacuum level is low enough to cause the most volatile of the solvents to be partially lost from the condenser *if they were still there.* With an auto drain cycle partway through the run, of course, the most volatile solvents will already have been removed.

There is also the potential in special cases to apply full vacuum for final drying of samples after removing a volatile bulk solvent. If, for example, a sample dissolved in TFA is tough to get finally dry, dropping to full vacuum at the end is not an option with a trap full of TFA. But if the trap has been emptied, first, no problem.

Easier Creation of Methods

When the EZ-2 was first launched, there was a facility for one extra "custom" method to be added to each instrument. The method would be created by the Genevac R&D department and would be mailed to the user on a "datakey".

With the EZ-2 Elite that process has moved on a long way. The new instrument has a large selection of (factory loaded) methods these can be replaced with custom methods as required. Furthermore, local Genevac agents are trained and equipped to generate these methods. Installation of the new method is still as easy as plugging in a datakey and turning on the system, however.

Not for everyone

The EZ-2 Elite does not completely replace the existing EZ-2. Not everyone has a requirement for DMSO removal or lyophilisation and the compact all in one EZ-2 Plus is still the ideal system for many applications.

But with the EZ-2 Elite, these options are now available.

Can I upgrade to an Elite?

Some EZ-2 Plus systems can be upgraded.

Contact Genevac with your instrument serial number if this is of interest.

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I always wondered … Can my samples be lyophilised?

This is a common application support question.

It depends on the solvent mixture, proportions, and concentration.

Solvents

Lyophilisation in the Genevac system requires that the solvent boiling point can be reduced to well below its freezing point by the application of vacuum.

This rules out most solvents, but water, butanol, dioxane and (to a lesser extent) DMSO are theoretical candidates.

Concentration

Causing a sample to freeze by applying vacuum results in some solvent being lost before freezing occurs.

It therefore stands to reason that if the solution is saturated then

- there will be precipitation as soon as solvent is removed
- the presence of so much solute may actually impact the freezing point of the solvent, making it harder to freeze.

Solvent Mixtures

The most common case is HPLC fractions containing MeCN/ H_2O or MeOH / H_2O. The typical route for lyophilisation is to remove the organic phase by conventional evaporation, then freeze the remaining water and lyophilise it (or else remove some water by conventional evaporation and **then** freeze and lyophilise it).

If the sample crashes out when the organic phase is removed, then nothing you do to the remaining water will give you a truly lyophilised end result.

You may be able to determine the likelihood of this in advance (either computationally with a solubility prediction program, or by observing where in the gradient the sample eluted. But realistically it will require some trial and error and may change with different overall chemistries.

Sample structure

Even with all other factors positive, there is always the possibility that certain compounds will not lyophilise as well as others

In Summary

First ascertain whether the task is broadly feasible (based on solvent type and proportions).

Then attempt q simple conservative test (which may take all night but will at least show if lyophilisation is going to work). If the results are positive, consider optimising the run for minimal runtime.

Note, however, that if a sample cannot be lyophilised from it's original solvent mixture, it may be possible to dry it conventionally re-dissolve it in a more suitable solvent for lyophilisation (i.e. water or dioxane).

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