Development of New Equipment Qualification Procedures dedicated to GPC-SEC Analysis

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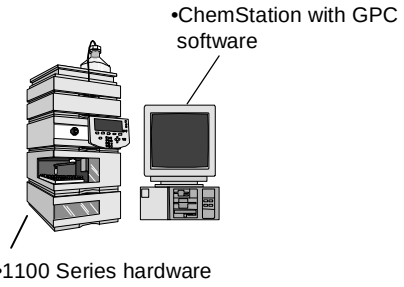
Introduction and problem

Many analytical polymer laboratories already work under GLP/ISO 9000 regulated conditions. The number will increase in the coming years.For these laboratories it is a must that the software is factory validated and the instrumentation including software passes regular qualification tests.
Most instrument manufacturers nowadays provide either manual or automated procedures, which show that hard- and software operates according to specifications. But, these tests are developed for typical HPLC analyses and are often not suited for the qualification of GPC-SEC systems.
A further lack is sufficient, but comprehensive information on the many parameters influencing precision and accuracy of molecular weight data. The user has therefore to go through a long learning curve with often questionable data.

Agilent 1100 Series GPC System concept

- **Validated GPC software**
- **Qualification procedures dedicated to GPC-SEC**
- **Full line of general HPLC qualification procedure**
- **GPC-SEC Start-up kits**



Qualification Procedures dedicated to GPC-SEC

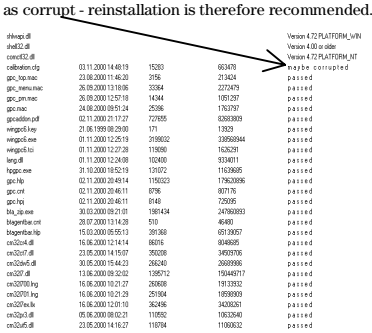
- **GPC Installation verification**
- **GPC System verification**
- **GPC System performance test**
- **GPC Operational Qualification/Performance Verification**

Full line of general HPLC Qualification procedures

The Agilent 1100 Series HPLC is available with a full line of qualification solutions for the entire life of the equipment. The lifetime is broken into the following areas: Design qualification(DQ), installation qualification(IQ) and operational qualification(OQ)/performance verification(PV), analytical method validation, performance qualification (PQ) and electronic record protection. For an overview on the available solutions for these steps refer to the brochure "Five steps to fast, cost-effective and successful validation", Agilent publication number5968-9104E".

GPC Installation verification

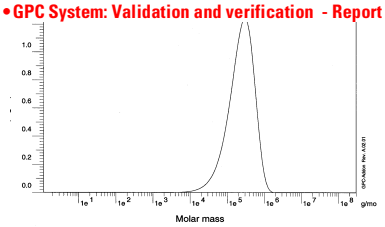
A software included utility verifies correct software installation, for example that all files are loaded and not corrupt. In the example below one file was identified as corrupt - reinstallation is therefore recommended.



GPC System: Software validation and verification

- It is a common request in regulated laboratories to periodically provide evidence that a software is calculating properly. The ChemStation GPC data analysis software is validated and features a system verification as a separate function. This can be performed at any time:
- A data and a calibration file - provided as a protected part of the program - will be generated as a print-out. The data file is obtained from an exactly known, theoretical Schulz-Flory distribution.
- Since the results are known the software calculations can be verified.
- The GPC raw data from the known sample are processed in exactly the same way as data which will be acquired by the ChemStation. This ensures that not only the final calculations are verified but also the complete data processing path.
- System verification is passed when the test results differ less than 0.5% from the expected results (for an example see next page).

•GPC System: Validation and verification - Report



Sample :	C:\Temp\Ps_valid.TXT		
Injection Date :			
Calibration File :	C:\Temp\Ps_valid.CAL		
Calibration Date :			
Baseline from :	6.000 min	**Baseline to :**	26.000 min
Integration from:	6.000 min	**Integration to :**	26.000 min
MHK - A (Cal.):	7.140000E-1	**MHK - K (Cal.):**	1.363000E-2 ml/g
Eluent :	THF	**Flowrate :**	1.000 ml/min
Concentration :	4.343 g/l	**Inject volume :**	20.000 ul
Column 1 :	Validate	**Temperature :**	23.000 C
Detector 1 :		**Delay volume :**	0.000 ml
Operator :	Validator	**Acquisition Interval :**	1.000 sec

	Validate		Expected Result
Mn :	1.5000e5	g/mol	1.5 0 0 0 e5
Mw :	3.0001e5	g/mol	3.0 0 0 0 e5
Mz :	4.5000e5	g/mol	4.5 0 0 0 e5
Mv :	2.8016e5	g/mol	2.8 0 8 7 e5
D :	2.0000e0		2.0 0 0 0 e0
[n]:	1.0567e2	ml/g	1.0 5 6 7 e2

GPC System Performance

The most important property of a GPC equipment is the quality of the column or column combination. The Agilent 1100 GPC data analysis software calculates per mouse click the below parameters. This enables a fast and comfortable control of the column(s) performance according to international GPC standards ASTM D5296, ISO 13885, DIN 55672).

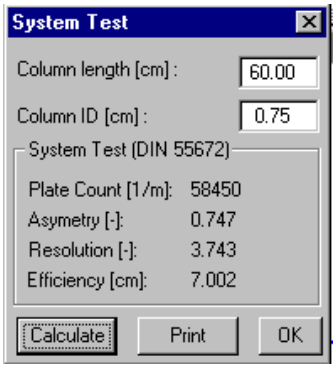
Parameters calculated by the System test utility:

- Plate count
- Asymmetry ($A = w_l/w_r$) , w is peak width on left or right side of peak
- Resolution $R_{sp} = R_s / \lg(M_1/M_2) = 0.579 / \sigma \times D$ with D of slope of the calibration curve

$R_s = V2 - V1 / 2 (\sigma_1 + \sigma_2) = \lg (M_1-M_2) / 2 \times D \times (\sigma_1 + \sigma_2)$

R_{sp} specifies the quality of two peaks, whose molecular weight differ by a factor of 10, limit =/> 1.7 (ASTM D5296)
Efficiency = $V_e(M) - V_e(10xM)$/area of column cross section. ISO 13885 and DIN 55672 specify > 6cm, i.e. the separation distance between both peaks must be a minimum of 6cm.

•GPC System Performance - Report



GPC Operational Qualification/Performance verification (OQ/PV)

Operational qualification is the process of demonstrating that an instrument will function according to the operational specification in the selected environment.
The tests have to be performed by the user on a regular basis. In general, users should select time intervals so the probability is high that all parameters are still within the operational specifications.

The 1100 Series GPC system concept

- Automated OQ/PV of the GPC data analysis software (see chapter Software validation and verification)
- GPC-SEC specific OQ/PV of equipment hardware and software.

This includes rigorous performance testing of the instrument using the certified broad test samples and the step-by-step procedure described in the instruction manual of the start-up kits (see below) . The factory recommended acceptance criteria can be modified by the operator.

GPC-SEC Start-up kits

Objectives

- To make the entry into and the life in the complex world of GPC-SEC as quick, simple and trouble-free as possible
- Step-by-step procedures for the guided development of the data acquisition-, GPC data analysis- and reporting part of broad test samples
- Discussion of parameters influencing precision and accuracy
- Chapter about trouble shooting
- Chapter about typical applications
- Available for organic- and water-soluble polymers

Contents Start-up kits

- Highly efficient PLgel Mixed-C or PL aquagel-OH Mixed column
- Ready-to-use mixtures of polymer standards
- Certificates of Analysis for column and standards
- Instruction Manual with step-by-step procedures

Conclusions

The new equipment qualification procedures are dedicated to GPC-SEC analyses. They are in compliance with international GPC standards as ASTM D 5296, ISO 13885 and DIN 55672.
Along with a most complete offering for general HPLC equipment qualification procedures they will significantly increase the confidence into the molecular weight data on operator-, customer- and auditor side.
The new Start-up kits are developed to enable a fast entry into and a successful life in the complex world of GPC-SEC.
The certified broad test samples and the step-by-step procedures supplied with the kits are recommended for GPC-SEC Operational Qualification/Performance verification (OQ/PV) of the used hardware and software.