

Felix Compounds confirms its position as industry leader thanks to Quantisweb

THE STAKES

Felix Compounds is renowned for its research and development work in thermoplastic elastomers, reinforced thermoplastics, expanded elastomers and engineering plastic compounds.

Constantly striving to provide customers with leading-edge products that meet their needs, Felix Compounds has made environmentally responsible product development one of its priorities. To help Felix carve out an enviable position for itself in this market it has a team of pioneering researchers ready to take up any challenge. So when a customer submitted a particularly interesting proposal, they didn't hesitate for a moment. They were asked to create a new thermoplastic elastomer (TPE) with very specific properties involving a blend never before prepared at Felix Compounds.

ABOUT TPEs

Thermoplastic elastomers (TPE) are a class of copolymers or a physical mix of polymers, which consist of materials with both

thermoplastic and elastomeric properties that soften/melt when heated and harden when cooled.

Benefits:

- Easy to mould
- 100% recyclable
- Wide range of hardness
- Can be easily coloured

Drawback:

- Low thermal stability

The team set about tackling the problem using traditional development methods; unfortunately, the results were far from conclusive.

Cornelia Candrea, Group Manager of Research and Development at Felix Compounds, explains:

"It was a complicated process. After dozens of experiments and having invested major material and human resources, we were still trying to determine which filler and lubricant were needed and defining the ingredient and extrusion process variables. In the meantime, our customer was counting on us to provide exactly the right product to meet their requirements."

SYNOPSIS

COMPANY

Felix Compounds is a leader in the development of thermoplastic elastomers, reinforced thermoplastics, expanded elastomers and engineering plastic compounds. FEPAC (Federation of Plastics and Alliance Composites) presented Felix Compounds with the 2010 "Honoris Innova" award in the Sustainable Development category for its efforts in improving the environmental performance of its products.

CHALLENGE

To develop a new TPE that would meet a customer's specific requirements within a reasonable time period while making effective use of limited investment and resources.

SOLUTION

Quantisweb optimization software.

RESULTS

A TPE compound is produced that meets all the customer's criteria. An innovative new product is launched on the TPE market. Minimal production variability.

THE SOLUTION

If Felix Compounds has built a solid reputation in the compound industry it is because it does not hesitate to use state-of-the-art technology. To solve this challenge, it turned to a solution offered by Quantisweb: Quantisweb multi-criteria optimization software.

This software uses an approach that works in the opposite way to any other method on the market; rather than attempting to predict the behaviour of a few critical variables, it works towards reaching defined product objectives. Proper training is required to use this application, that is why Nina Visconti, Vice President of Strategic Development at Quantisweb, accompanied the Felix Compounds research team throughout the process.

Together, they entered the eight properties of the customer's desired product (flow, traction, elongation, hardness, abrasion, gloss, density and moisture) as well as the ingredients and process variables required for the blend. The Felix Compounds team also identified and entered 21 constraints that existed between the ingredients and the manufacturing process variables.

It was a complex experiment. The proportions for the main elastomer, two polymers and the adhesive had to be established. In addition, the filler (one of two possible options) and lubricant (also one of two possible options) had to be defined in order to produce the desired properties. Lastly, the interval values of the six process variables involved

in making the TPE had to be determined. With all these conditions, twelve combinatorial paths were possible (see Table 1: Combinatorial paths). The right path had to be found in order to solve the problem.

From the original 14 parameters (eight for the ingredients and six for the process), their mixed variable levels and associated constraints, the Quantisweb algorithm generated a set of 15 experiments (Np+1) (see Table 2: Design of experiments). The results of these experiments, carried out in the laboratory (see Table 3: Results of experiments), were entered into the system which, after optimization, finally selected the filler and lubricant to use.

TABLE 1 : COMBINATORIAL PATHS

COMBINATORIAL PATH	PARAMETER									
	1	2	3	4	5	6	7	8	9	10
1	X	X	0	0	X	0	0	X	X	0
2	X	X	0	0	X	0	0	X	X	0
3	X	X	0	0	0	X	X	0	X	0
4	X	X	0	0	0	X	0	X	X	0
5	X	0	X	0	X	0	X	0	0	0
6	X	0	X	0	X	0	0	X	0	0
7	X	0	X	0	0	X	X	0	0	0
8	X	0	X	0	0	X	0	X	0	0
9	X	X	X	X	X	0	X	0	X	X
10	X	X	X	X	X	0	0	X	X	X
11	X	X	X	X	0	X	X	0	X	X
12	X	X	X	X	0	X	0	X	X	X

Global constraint : $98,5 \leq \text{SUM}(\text{parameter } 1 : \text{parameter } 8) \leq 99,5$

TABLE 2 : DESIGN OF EXPERIMENTS

EXPERIMENT	PARAMETER													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	16	15	5	5	10	0	48	0	180	230	234	200	30	70
2	26	5	10	15	18	1	25	1	230	190	256	150	75	30
3	22	0	14	0	18	0	45	0	0	0	246	180	60	40
4	21	11	0	0	18	1	49	0	220	0	240	170	55	40
5	22	8	16	12	13	1	28	1	215	203	256	175	55	50
6	23	0	12	0	16	1	48	1	0	0	248	155	45	30
7	25	6	9	9	10	1	40	0	225	195	252	155	65	50
8	18	7	13	10	11	0	40	0	204	227	238	185	40	50
9	17	16	5	16	15	1	30	1	228	206	250	195	70	30
10	20	14	0	0	16	0	49	0	185	0	244	165	50	30
11	23	13	7	14	15	0	27	1	210	200	250	160	60	40
12	24	9	0	0	17	1	49	1	190	0	254	190	65	70
13	21	10	11	11	14	0	32	1	200	215	234	180	35	40
14	25	0	15	0	12	0	47	0	0	0	236	200	35	70
15	19	12	8	13	13	0	34	1	195	218	242	185	50	60

"I was curious to see the results because I found some of the combinations very intriguing. Quantisweb validated our hypotheses and enabled us to systemize our research plan," Ms. Candrea said. She analyzed the results after every experiment and compared them to the values established for the eight desired properties.

With only thirteen new experiments comprising thirteen levels and two constraints, the process was repeated a second time and revealed that hardness—one of the properties sought—would be difficult to achieve with the original ingredients. Consequently, Ms. Candrea decided to change two ingredients.

The new list of ingredients, as well as the processes and constraints were again entered into Quantisweb, and the process was repeated a third time and generated thirteen new experiments with thirteen levels and two constraints. The results of those experiments showed that the optimal values of the parameters were finally attained. **The formula for the desired product and manufacturing process had finally been achieved** (see Table 4: Desired interval for properties vs obtained values).

Ms. Candrea's open-mindedness was rewarded: Felix Compounds has confirmed its position as an industry leader thanks to Quantisweb. Highly satisfied, she declares: "I would not hesitate to call on Quantisweb's services for future projects."

THE QUANTISWEB ALGORITHM

Quantisweb's global approach reduces the number of laboratory experiments to $N_p + 1$, where N_p is the number of ingredients and process variables involved in creating a product. Quantisweb generates the optimal values for all ingredients and process variables simultaneously.

INDUSTRIAL APPLICATIONS:

- Product formulation
- Process engineering
- Validation or optimization of existing products or processes

APPLIES TO BATCH OR CONTINUOUS PRODUCTION PROCESS IN SUCH TECHNOLOGY SECTORS AS:

- Biotechnology
- Chemicals
- Composites and compounds
- Cosmetics
- Food products
- Metallurgy
- Petrochemicals
- Pharmaceuticals
- Pulp and paper
- Others

TABLE 3 : RESULTS OF EXPERIMENTS

EXPERIMENT	PROPERTIES									
	FLOW	RESISTANCE		HARDNESS		ABRASION	GLOSS	DENSITY	MOISTURE	
		TRACTION	ELONGATION	20 MINUTES	24 HOURS				GRANULE	MOLDING
1	0	0	0	0	0	0	0	0	1	1
2	10,9	741	191	80,5	83	0	4,6	1,03	0	0
3	53,8	672	330	65	65	295	4	1,02	0	0
4	75,1	382	252	28	31	0	8,3	1	0	0
5	21,2	796	184	85	84	130	4,4	1,03	0	0
6	49,5	947	645	55	56	140	9,2	1	0	0
7	48	625	311	60	60	240	4,3	0,97	0	0
8	52,3	660	458	85	76	200	4,6	0,99	0	0
9	58,6	539	92	87	86	250	7,4	1,03	0	0
10	42	804	237	30	32	270	10,2	1	0	0
11	27	660	187	76	80	470	4,9	1,05	0	0
12	28	878	739	26	30	60	8,3	1,01	0	0
13	35	796	740	76	79	280	3,3	1,02	0	0
14	56	575	191	58	61	200	6,4	1,01	0	0
15	81	599	79	79	82	690	5,8	1,01	0	0

TABLE 4 : DESIRED INTERVAL FOR PROPERTIES VS. OBTAINED VALUES

PROPERTIES	DESIRED INTERVAL	OBTAINED VALUE
Flow	0 - 30	1,4
Traction	700 - 1200	1068
Elongation	200 - 800	200
Hardness	50 - 56	51
Abrasion	200 - 300	299
Gloss	3,0 - 4,0	3,7
Density	0,96 - 1,02	0,96
Moisture	0	0

THE BENEFITS

Quantisweb proposed a solution that:

- met the customer's requirements.
- maintained a low variability in the manufacturing process.
- helped launch an innovative new product on the TPE market.

These were precisely the benefits that Felix Compounds had hoped for.

Furthermore, Quantisweb provided a solution that allowed Felix Compounds to satisfy all of their customer's requirements without having to hire a statistician or DOE expert.

In the end, this solution consolidated Felix Compounds' position as a leader in product development and the production of leading-edge, environmentally responsible products.

ABOUT QUANTISWEB

Quantisweb is a multivariate optimization methodology and software for the integrated development of both complex materials and industrial processes required to manufacture them. This patented application combines three mathematical domains and can generate a formula for real or virtual products

or processes. Quantisweb helps develop high performance products with the input of users' expertise. The desired properties, ingredients, manufacturing processes and constraints are used to determine the product formula required to achieve the product desired properties.

"I was very sceptical at first but decided to give Quantisweb a try. As far as I was concerned, nothing can replace a researcher's experience. However, I am delighted with the results. It is user-friendly software; the steps are clear and logical, and the formulas, results and reports are visually well structured, making them easier to analyze. The Quantisweb methodology suggested experiments I never would have attempted intuitively. I certainly learned a few new things. The results confirmed some of my predictions and negated others. The Quantisweb software guides the expert; it does not replace the expert."

Cornelia Candrea,
Group Manager of
Research and
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To learn more about Quantisweb,
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