Design of Hydraulic Quick Coupling Using DFA Lucas

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Abstract. The paper deals with the design of the hydraulic quick coupling, which is based on specified parameters of international standard ISO 16028. The goal was to simplify the assembly of the quick coupling using innovative methods. Design for Assembly is a method used for reducing the complexity of the assembly, which could lead to lower the costs of the final product. The most effective use of the (DFA) method is at the beginning of the innovation process.

Keywords: Hydraulic Coupling · Fluid Leak · Quick Disconnect · Design for Assembly

1 Introduction

Hydraulic quick coupling is a device consisting of two parts (male and female) primarily used in agriculture to connect and disconnect the hydraulic circuit of a tractor to other agricultural machinery. During the connection and the disconnection is a possibility of losing the fluid and contamination the hydraulic circuit, which could lead to destroying the hydraulic pump. To prevent these situations, non-spilled hydraulic quick coupling was invented. The flat face valve is a key feature, which minimizes trapped air in the circuit and prevents leaking of the fluid during connection and disconnection. Preventing a fluid leak is a very important matter to keep our planet clean, especially nowadays. Only a small amount of leaked oil can lead to pollution of million litres of water and other environmental issues [1].

Hydraulic quick coupling consists of many parts resulting in difficult assembly. The aim of this article was to reduce the number of parts to shorten assembly time, included reduction of fluid loss during connection and disconnection according to the international standard ISO 16028.

2 Materials and Methods

DFA Lucas is a numerical method used to evaluate designed assembly based on values scales. Firstly, the assembly parts are divided into two groups based on function analysis. The first group contains parts, which are essential for the main function of the assembly.

J. Homišin et al. (Eds.): ICMD 2020, AHE 17, pp. 50–54, 2023.
https://doi.org/10.2991/978-94-6463-182-1_7

The second group contains parts, especially connecting material, which are necessary to complete the assembly, but are not essential for the main product function. The next step is to evaluate the feeding and fitting ratio. The last output from the method is design efficiency [3, 4].

Design efficiency can be calculated by Eq. (1)

$$design\,efficienty = \frac{A}{(A+B)} \cdot 100\% \tag{1}$$

where A is a group of essential components, B is a group of connecting materials.

The feeding ratio can be calculated by Eq. (2)

$$feeding\ ration = \frac{feeding\ index}{A} \cdot 100\% \tag{2}$$

where the feeding index is chosen by manual handling analysis, A is a group of essential components.

The fitting ratio can be calculated by Eq. (3)

$$fitting\ ration = \frac{fitting\ index}{A} \cdot 100\% \tag{3}$$

where the fitting index is chosen by manual fitting analysis, A is a group of essential components.

3 Results and Discussion

Components of an original male part design were recorded in Table 1 according to the DFA Lucas method. The most significant result is design efficiency, which should reach a minimum of 60%.

The design efficiency of the original design evaluated by the Eq. (1) is 50%. Overall assembly of the male part is shown in Fig. 1.

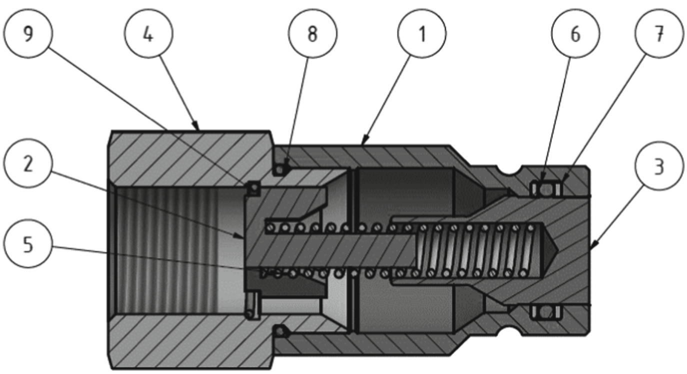

Fig. 1. The original design of hydraulic quick coupling.

Table 1. Components of original hydraulic quick coupling.

Parts	Position	Function analysis	Fitting analysis	Feeding analysis
Male Body	1	A	1	1
Induction element	2	A	1,3	2,6
Flat valve	3	A	1,3	2,6
Modular end	4	B	4	5,3
Spring	5	B	1,3	1,6
Seal ring 15,6x2,3	6	A	4,2	6,5
Support ring 2x	7	B	6,9	6,5
Seal ring 22x1,5	8	A	2,7	5
Stop ring	9	B	6,9	6,5
Overall	**10**	**5**	**36,5**	**44,4**

Table 2. Components of optimized hydraulic quick coupling.

Parts	Position	Function analysis	Fitting analysis	Feeding analysis
Male Body	1	A	1	1
Induction element	2	A	1,3	2,6
Flat valve	3	A	1,3	2,6
Modular end	4	B	4	5,3
Spring	5	B	1,3	1,6
Seal ring 15,6x2,3	6	A	4,2	6,5
Support ring 1x	7	B	6,9	6,5
Seal ring 22x1,5	8	A	2,7	5
Overall	**8**	**5**	**22**	**30,4**

The original assembly consists of 10 elements. An induction element is attached to the modular end, where is a groove, into which is inserted a stop ring serving as a safety feature against falling off the modular end. This solution is a little bit clumsy. If we wanted to disassemble the male part, there is no solution how to achieve it without destroying the stop ring.

Components of the optimized male part design were recorded in Table 2 according to the DFA Lucas method.

The design efficiency of the optimized design is 62,5%. Overall assembly of the optimized male part is shown in Fig. 2.

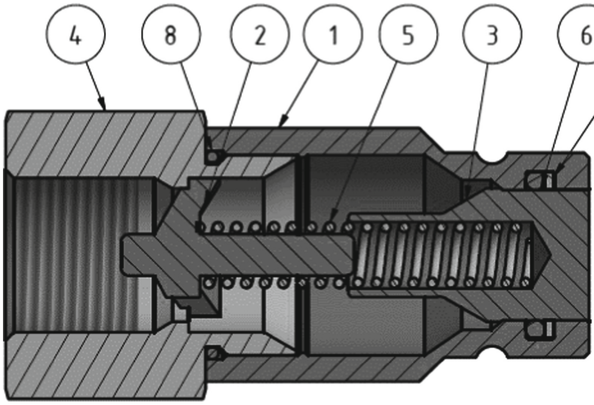

Fig. 2. Optimized design of hydraulic quick coupling.

Optimized design Fig. 2 consists of only 8 elements. The stop ring was removed completely. The induction element is directly attached against the shaped element inside the modular end. This solution makes assembly and disassembly much easier without destroying any parts. There was also removed one support ring.

4 Conclusions

The article dealt with the design of the hydraulic quick coupling according to the international standard ISO 16028, which is used for hydraulic machines and devices.

The original design of the male part was evaluated by numerical method DFA Lucas with a finding of a few weak spots. Those weak spots were adjusted by the new design, which led to general improvements in the design efficiency of the assembly.

Acknowledgements. This publication was written at the Technical University of Liberec, Faculty of Mechanical Engineering with the support of the Institutional Endowment for the Long Term Conceptual Development of Research Institutes, as provided by the Ministry of Education, Youth and Sports of the Czech Republic in the year 2020.

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