



Using Response Surface Analysis to Estimate Time of The Gas-Water Contact Lift in Yamburg Gas Field Conditions

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ABSTRACT

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Like many of the fields in northwest Siberia, the Yamburg oil and gas condensate field is in the final production stages. This, therefore, results in an accumulation of a large amount of formation water in the inflow at the bottom of the well. Response surface analysis is used as a new technique to gain a detailed understanding of the relationships between combinations of two predictor variables and an outcome variable. This approach was applied to the Yamburg field to estimate the time of the gas-water contact, considered as the result variable, by taking into account two groups of predictive variables which correspond to the reservoirs grouped by their lithological characteristics. The results of the predicted gas-water contact time were compared to the expected gas-water contact time, the data of which were taken into account for the study. Using the model parameters as well as the three-dimensional response surface, which was constructed to facilitate and improve the interpretation of the results, it was then possible to predict the gas-water contact time under certain conditions.

1. Introduction

Fluid accumulation is the most common occurrence in gas wells especially when the gas field reaches its late stage of development. There are almost no well-defined studies on determining the time that gas-water contact takes in gas fields. The importance of this research lies in estimating the level of gas-water contact for a future period, knowing the thicknesses of rock layers, and not having various data such as those on geophysics among others.

The Cenomanian reservoir of the Yamburg oil and gas condensate field (YOGCF), not being an exception to other large deposits located in the north of the West Siberian Plain, is therefore at a late stage of development, which is characterized by low reservoir pressures, a high degree of water cut, a low production capacity of the reservoir, collapsing reservoirs [1-4].

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For the Yamburg oil and gas condensate field (YOGCF), according to the lithological description and physical properties (Table 1), five groups of gas-producing reservoirs are distinguished. The reservoir-non-reservoir boundary passes through the rocks of group 5 in terms of filtration-capacitive parameters [5].

Reservoirs of group 1 are represented by three types of sandstones - super-reservoirs, reservoirs with improved porosity and filter-capacitive properties (reservoir properties), and reservoirs with poor reservoir properties (three-modal porosity distribution).

The second group is represented by reservoirs with a significant range of changes in capacitive properties (0.24 - 0.37) (multimodal distribution of porosity and residual water saturation), which once again indicates a mixed composition of this group - siltstones and interbedded siltstones with sandstones and clays (groups 1, 3, 5).

Reservoirs of group 3 are represented by a unimodal distribution of porosity and water saturation - this is due to the thin interlayering of mainly sandy-siltstone components on the scale of the core sample; the estimation of the reservoir properties of this group is quite possible due to the quasi-uniformity on the scale of core samples.

Reservoirs of group 4 are represented by a two-modal distribution of porosity and water saturation - this is due to the inclusion of individual clay samples (group 5) and samples with thin interlayering of clay-silt components on the scale of the core sample (group 3).

Reservoirs of group 5 are represented by a three-modal distribution of porosity and water saturation - this is due to the inclusion in this group, along with clay samples, of some samples represented by interlayering of clay-silt components (groups 3, 4).

As for almost all the fields located in the Yamal-Nenets region, to which belongs the Yamburg gas field, the latter is characterized by a complex system of tectonic faults [5-7].

Table 1
 Boundaries of collector groups by capacitive parameters

Group number	Collector characteristics	Lithology	$\Phi_{\min.}$	$\Phi_{\max.}$	$\Phi_{\text{avg.}}$	$S_{\text{wr,avg}}$
1a	Super collector	Weakly cemented sandstone	0.39	0.45	0.396	0.116
1b	Improved	Sandstone	0.36	0.39	0.371	0.135
2	Good	Silty sandstone	0.32	0.36	0.34	0.168
3	Deteriorated	Siltstone	0.28	0.32	0.301	0.272
4	Interbedding of deteriorated reservoirs with rocks having an initial gradient	Interbedding of sandstones, siltstones and clayey siltstones	0.24	0.28	0.258	0.45
5	Interbedding of initial gradient reservoirs and non-reservoirs	Interbedding of sandstones, clayey siltstones and clays	0.18	0.24	0.212	0.74

$\Phi_{\min.}$, $\Phi_{\max.}$, $\Phi_{\text{avg.}}$: respectively minimum, maximum and average porosity; $S_{\text{wr,avg}}$: average residual water saturation

At present, there is no work dealing with the statistical aspect of the prediction of the rise of the gas-water contact surface in gas fields. Considering the lithology of the 5 groups of reservoirs, the question is to determine the influence of these different groups on the time the gas-water contact takes when it moves at depth.

Thus, combined with technical solutions allowing the elimination of liquids from flooded gas wells, this method would make it possible to anticipate the water level and maintain the gas-producing strata in such a non-flooded state that the production of gas wells would remain considerable [8-10].

2. Data Collection

Data collection, which constituted the very first phase of the task, was carried out on a large number of wells. A total of 31 wells were selected among about eighty, distributed across all well clusters, and their data were processed. In this study, a model was developed to predict the timing of gas-water contact levels.

For each well, the thicknesses of different rock layers were measured, citing their differences at the lithological level. These were the thicknesses of different layers crossed by the gas-water contact during a certain period of time (in the number of days). 170 intervals were identified as valid and were considered as raw data.

All rock layers, related to the 5 lithological groups, were distributed. For each given gas-water contact interval of time, all 5 groups of reservoirs are not necessarily represented.

3. Method Execution and Results

Response surface analysis has been applied in various fields of science, but remains an insufficiently substantiated question especially on the issue of flows in underground environments [11-19].

The method is a relatively new technique that can provide detailed insight into the relationships between combinations of two predictor variables and an output variable by plotting the results of polynomial regression analysis in 3D space [20,21].

It should be noted that the model includes all possible second-order terms. This is useful because skipping members implies information that certain types of surfaces cannot be encountered, which would be unthinkable without skipping members. Such cases are not common. When such information is available, research can usually be conducted on a more rigorous theoretical basis.

This method has more informative potential than, for example, traditional regression analysis, and is promising for application to a wide range of research questions.

Based on their respective values of porosity and residual water saturation coefficients, two predictors that relate to our question have been identified. These two predictors are, on the one hand, an assembly of the first three groups of reservoirs, which we will call high porosity reservoirs (HPR), and on the other hand, an assembly of the last two groups of reservoirs, which we will call low porosity reservoirs (LPR).

According to several authors, the assumptions necessary to implement the method have been met [22]. Any difference in the position of the two predictor variables was understood in a meaningful way because the predictors were commensurable; that is, they represent the same conceptual area.

The second assumption, which was fulfilled, states that the predictor variables must be measured on the same numerical scale in order to determine their degree of fit [22].

In conclusion, as with any regression method, all the usual assumptions of multiple regression analysis must also be met (for a list of these assumptions, see the study by Tzagkarakis *et al.*, [23]).

In the response surface analysis approach, polynomial regression is performed first. The general form of the equation for testing relationships using polynomial regression is as follows

$$Z = b_0 + b_1X + b_2Y + b_3X^2 + b_4XY + b_5Y^2 + e \quad (1)$$

where Z – the dependent variable (time interval, in days), X is predictor 1 (width of high porosity reservoirs, in meters), and Y is predictor 2 (width of low porosity reservoirs, in meters).

Thus, the original variable is determined by the regression of two predictor variables (X and Y), the interaction between the two predictor variables (XY), and the square of the terms for each of the two predictors (X^2 and Y^2).

Using polynomial regression and subsequent analysis of the response surface, one can inspect: (i) How is the correspondence (agreement) between the two predictor variables (X and Y) related to the final variable (Z), (ii) how is the degree of mismatch (discrepancy) between the two predictor variables (X and Y) related to the outcome (Z), and finally (iii) how is the direction of the discrepancy between the two predictor variables (X and Y) related to the final variable (Z).

Rather than directly interpreting the results of the polynomial regression analysis, the coefficients from the analysis are used to explore what is called the “response surface model”, which is presented as a three-way visual representation of the data to facilitate interpretation [24,25].

Before performing the polynomial regression analysis, a test was performed to find out how many time intervals would be related to discrepancies between the two predictors, so that the baseline of discrepancy in the sample was presented [26].

With this information, there was an idea of the discrepancies that exist in the sample, how many, and in which direction. Since many intervals were found to have discrepant values (for example, HPR higher than LPR or vice versa), the practical value of studying how the discrepancies affect the outcome variable was great. A total of 36.5% of HPR and 4.7% of LPR were considered inappropriate. This means that 58.8% of the data was in agreement.

Since we made sure that there are discrepant values in our sample, the polynomial regression was performed [27]. At first, the predictors (HPR and LPR) were centered around the midpoint of their respective scales, to simplify interpretation and reduce the likelihood of multicollinearity [22,24,28-32]. Then, three new variables were created: (a) the square of the centered HPR variable; (b) the cross product of the centered variable HPR and LPR; and (c) the square of the centered LPR variable. Then polynomial regression analysis was performed. This was done by regressing the final variable (time interval) against the centered predictor variables (HPR and LPR), the square of the centered HPR variable, the cross product of the centered variable HPR and LPR, and the square of the centered variable LPR.

Rather than examining the regression coefficients, as would be done in a conventional regression analysis, if R^2 (the variance of the original variable explained by the regression equation) is significantly different from zero, the polynomial regression results are estimated against the four values of the surface test: a_1 , a_2 , a_3 and a_4 [22]. The results of the analyzed samples are shown in Table 2. The slope of the line of ideal agreement (HPR = LPR) in relation to the displacement time of the gas-water contact (TGWC) is defined as $a_1 = (b_1 + b_2)$, where b_1 – the non-standard beta coefficient for centered HPR variable, and b_2 – the non-standard beta coefficient for centered LPR variable. The curvature along the line of ideal fit with respect to TGWC is estimated by calculating $a_2 = (b_3 + b_4 + b_5)$, where b_3 – the non-standard beta coefficient for the square of the centered HPR variable, b_4 – the non-standard beta coefficient for the cross product of the centered variable HPR and LPR, and b_5 – the non-standard beta coefficient for the square of the centered LPR variable. The curvature of the line of inconsistency with respect to TGWC, indicating the degree of discrepancy between the HPR, LPR and the result of TGWC, is estimated by calculating $a_4 = (b_3 - b_4 + b_5)$. The slope of the discrepancy line with respect to the TGWC, indicating the direction of the divergence (where HPR higher than the LPR or vice versa), is estimated by calculating $a_3 = (b_1 - b_2)$.

Table 2
 Coefficients and parameters of the model

Variables	TGWC (displacement time of the GWC)
Constant	b (se)
Constant	1057.881 (91.263)***
HPR (high porosity reservoirs)	102.21 (26.372)***
LPR (low porosity reservoirs)	163.032 (58.11)**
HPR ²	0.77 (2.373)
HPR x LPR	-23.902 (8.468)**
LPR ²	4.917 (15.037)
R ²	0.336***
Surface tests	
a ₁	265.24***
a ₂	-18.22*
a ₃	-60.82
a ₄	29.59

Note: N = 170

b – nonstandard regression coefficient, se – standard error

* p < 0.1; ** p < 0.01; *** p < 0.001

To facilitate and improve the interpretation of the results, a three-dimensional response surface was built and its features were investigated (Figure 1).

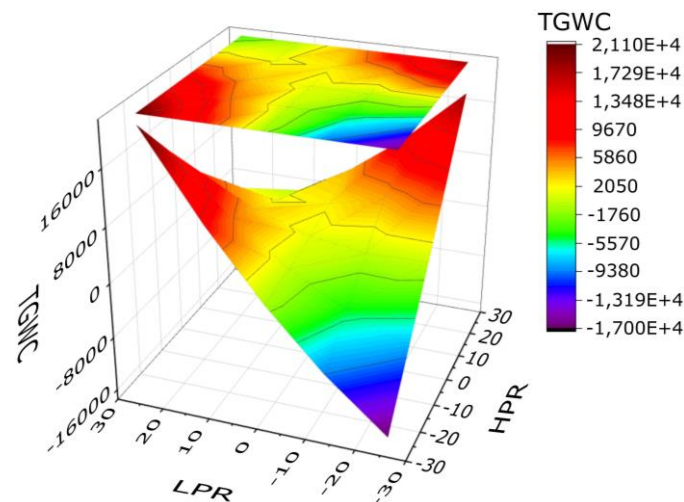


Fig. 1. Displacement time of the GWC (TGWC) in relation to the discrepancies of the HPR and LPR

The plot and calculated surface values have been interpreted with three concepts in mind. We considered, firstly, how the agreement in the HPR and LPR is related to the TGWC, secondly, how the degree of discrepancy between the HPR and the LPR is related to the TGWC, and thirdly, how the direction of the discrepancy between the HPR and the LPR is related to the TGWC.

The congruence hypotheses argue that the agreement between HPR and LPR should positively (or negatively) influence the TGWC. Since we were interested in whether the agreement between HPR and LPR could lead to the prediction of the TGWC, we compared the position of the ridge with a line in the XY plane (HPR-LPR), which contains all combinations of the predictors in agreement HPR = LPR. Therefore, we expressed the projection of the first major axis in the form of a linear equation connecting Y with X [22,33]

$$Y = p_{10} + p_{11}X \quad (2)$$

The p_{10} and p_{11} values can be computed from the estimated coefficients b_1 to b_5 in the polynomial regression equation. The line of perfect agreement – $Y = 0 + 1X$. The calculated p_{10} and p_{11} values are -1.19 and 16.67, respectively. These values do not suggest that the HPR and the LPR are in agreement, as p_{10} and p_{11} should be almost equal to 0 and 1 respectively.

From the interpretation of the degree of discrepancy between HPR and LPR, we concluded that in the direction of divergence (where $X = -Y$), the surface has a convex shape due to the value of a_4 , which is high and positive (29.59).

The assumption that a significant negative a_3 should indicate that the TGWC is higher when the agreement is such that the LPR is higher than the HPR is attested. However, in the case of this study, the result also suggests that when the HPR was higher than the LPR, the TGWC could have been higher, which does not really reflect reality. This weakness of the method led to some incorrect predictions (Figure 2).

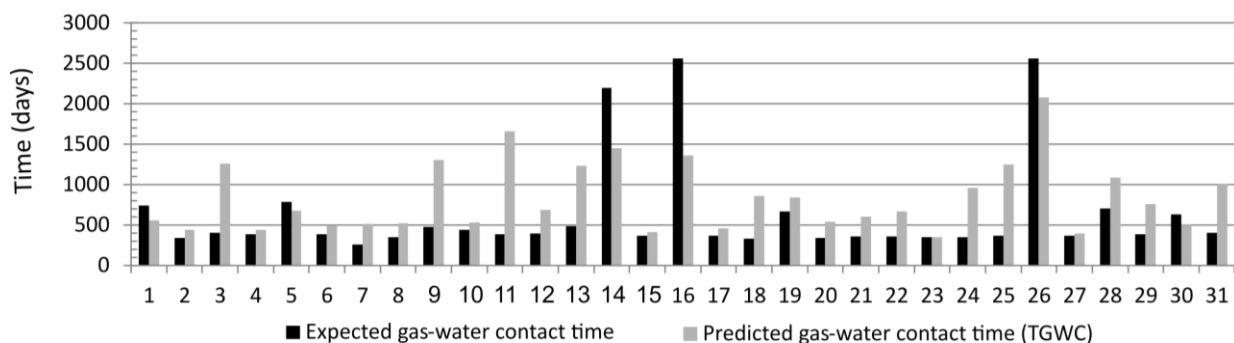


Fig. 2. The results of the predicted gas-water contact time (TGWC) compared to the expected gas-water contact time

It was found that the difference between the actual expected time and the predicted time is small for forecasts less than 1000 days.

4. Conclusions

It was observed that several factors may have contributed to the emergence of inaccuracies in the final results. For some measurements of the gas-water contact (GWC), inconsistencies were sometimes observed, thus representing a longer displacement time for the GWC in permeable layers and vice versa. This may be justified among other things by the structural architecture of the Yamal-Nenets region, to which belongs the Yamburg gas field, and which is characterized by a complex system of tectonic faults. In addition, over several intervals of rock layers, the GWC level was measured with uncertainty from the field.

The predictions could nevertheless be generated by the response surface analysis method, which could be refined by taking into account the information that was lacking for this work.

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References

- [1] Chupin, Gael, Bin Hu, Tor Haugset, Jan Sagen, and Magali Claudel. "Integrated wellbore/reservoir model predicts flow transients in liquid-loaded gas wells." In *SPE Annual Technical Conference and Exhibition*. OnePetro, 2007. <https://doi.org/10.2118/110461-MS>
- [2] Schiferli, W., S. P. C. Belfroid, S. Savenko, C. A. M. Veeken, and B. Hu. "Simulating liquid loading in gas wells." In *7th North American Conference on Multiphase Technology*. OnePetro, 2010.
- [3] Yakupov, Rustam R., and Natalia R. Yarkeeva. "Optimization of gas wells operation at the yamburg gas field." *Petroleum Engineering* 16, no. 3: (2018): 41-49. <https://doi.org/10.17122/ngdelo-2018-3-41-49>
- [4] Alexandrovich, Legkoonets Vladislav, Mardashov Dmitry Vladimirovich, and Morozov Alexander Viktorovich. "Water shut-off treatment efficiency forecasting in the context of yamburgskoe oil-gas condensate field." *PRONEFT. Professionally About Oil* 3, no. 9 (2018): 51-55. <https://doi.org/10.24887/2587-7399-2018-3-51-55>
- [5] Vniigaz, Gazprom. "Development and estimation of methods of local grinding of the hydrodynamic model depending on the detaility of the initial geological model." *Research Institute of Natural Gases and Gas Technologies – VNIIGAZ*. Moscow, 2005.
- [6] Gaidukova, A. A. "Geological structure and state of development of the Cenomanian deposits of the Yamburgskoye oil and gas condensate field." *Journals of Higher Educational Institutions Oil And Gas* 4 (2009): 13-19.
- [7] Kontorovich, V. A., S. Y. Belyaev, A. E. Kontorovich, V. O. Krasavchikov, A. A. Kontorovich, and O. I. Suprunenko. "Tectonic structure and history of the development of the West Siberian geosyncline in the Mesozoic and Cenozoic." *Geologiya i Geofizika* 42, no. 11-12 (2001): 1832-1845.
- [8] Kurkin, A. A. "Clarification of the prospects for oil and gas content in the east of Yamal based on a detailed model of geological development." *Industrial University of Tyumen*, 2019.
- [9] Drozdov, A. N., J. B. Mugisho, E. I. Gorelkina, Y. A. Gorbyleva, V. B. Ludupov, and V. D. Volkov. "A New Technical Solution for Liquid Removal from Flooded Gas and Gas Condensate Wells." *Territorija "NEFTEGAS" [Oil and Gas Territory]* no. 1-2 (2021): 56-62.
- [10] Mugisho, J. B., and N. A. Mirsamiev. "Calculation of the Minimum Required Flow Rates for Water Removal from Flooded Wells under the Conditions of the Yamburgskoye Field." In *IOP Conference Series: Earth and Environmental Science*, vol. 666, no. 6, p. 062013. IOP Publishing, 2021. <https://doi.org/10.1088/1755-1315/666/6/062013>
- [11] Nair, Abhilash T., Abhipsa R. Makwana, and M. Mansoor Ahammed. "The use of response surface methodology for modelling and analysis of water and wastewater treatment processes: a review." *Water Science and Technology* 69, no. 3 (2014): 464-478. <https://doi.org/10.2166/wst.2013.733>
- [12] Alman-Abad, Zahra Sheikhi, Hossein Pirkharrati, Farrokh Asadzadeh, and Mahdi Maleki-Kakelar. "Application of response surface methodology for optimization of zinc elimination from a polluted soil using tartaric acid." *Adsorption Science & Technology* 38, no. 3-4 (2020): 79-93. <https://doi.org/10.1177/0263617420916592>
- [13] Musa, Sabariah, Ng Le Bin, Adel Ali Saeed Abduh Algheethi, Nor Azazi Zakaria, and Lau Tze Liang. "Groundwater Analysis for Unconfined and Clayey Layer by using Response Surface Methodology." *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences* 69, no. 2 (2020): 168-176. <https://doi.org/10.37934/arfmts.69.2.168176>
- [14] Yu, Jianjun, Xiaosheng Qin, Ole Larsen, and Lloyd Hock Chye Chua. "Comparison between response surface models and artificial neural networks in hydrologic forecasting." *Journal of Hydrologic Engineering* 19, no. 3 (2014): 473-481. [https://doi.org/10.1061/\(ASCE\)HE.1943-5584.0000827](https://doi.org/10.1061/(ASCE)HE.1943-5584.0000827)
- [15] Kuczera, George. "Assessing hydrologic model nonlinearity using response surface plots." *Journal of Hydrology* 118, no. 1-4 (1990): 143-161. [https://doi.org/10.1016/0022-1694\(90\)90255-V](https://doi.org/10.1016/0022-1694(90)90255-V)
- [16] Song, LaiFu, Xiang Yu, Bin Xu, Rui Pang, and ZeYu Zhang. "3D slope reliability analysis based on the intelligent response surface methodology." *Bulletin of Engineering Geology and the Environment* 80, no. 2 (2021): 735-749. <https://doi.org/10.1007/s10064-020-01940-6>
- [17] Slotte, Per Arne, and Eivind Smorgrav. "Response surface methodology approach for history matching and uncertainty assessment of reservoir simulation models." In *Europec/EAGE Conference and Exhibition*. OnePetro, 2008. <https://doi.org/10.2118/113390-MS>
- [18] Rohmer, Jeremy, and Olivier Bouc. "A response surface methodology to address uncertainties in cap rock failure assessment for CO₂ geological storage in deep aquifers." *International Journal of Greenhouse Gas Control* 4, no. 2 (2010): 198-208. <https://doi.org/10.1016/j.ijggc.2009.12.001>
- [19] Rahman, Musfika, and Iskandar Dzulkarnain. "Response Surface Method for Modelling the Effect of CO₂ in Brine/Waxy Oil Interfacial Tension during LSW-WAG Enhanced Oil Recovery." *Journal of Advanced Research in Applied Sciences and Engineering Technology* 22, no. 1 (2021): 54-68. <https://doi.org/10.37934/araset.22.1.5468>
- [20] Shoesmith, Eddie, G. E. Box, and N. R. Draper. "Empirical Model-Building and RESPONSE SURFACES." *The Statistician* 37, no. 1 (1988): 82. <https://doi.org/10.2307/2348383>
- [21] Edwards, Jeffrey R., and Mark E. Parry. "On the use of polynomial regression equations as an alternative to

- difference scores in organizational research." *Academy of Management Journal* 36, no. 6 (1993): 1577-1613. <https://doi.org/10.2307/256822>
- [22] Edwards, Jeffrey. "Alternatives to difference scores: Polynomial regression analysis and response surface methodology." In *Measuring Analyzing Behavior Organizations: Advances in Measurement and Data Analysis.*, pp. 350-400. Jossey-Bass Inc, 2002. <https://doi.org/10.1037/e576892011-020>
- [23] Tzagkarakis, George, Thomas Dionysopoulos, and Alin Achim. "Recurrence quantification analysis of denoised index returns via alpha-stable modeling of wavelet coefficients: detecting switching volatility regimes." *Studies in Nonlinear Dynamics & Econometrics* 20, no. 1 (2016): 75-96. <https://doi.org/10.1515/snde-2014-0102>
- [24] Edwards, Jeffrey R. "The study of congruence in organizational behavior research: Critique and a proposed alternative." *Organizational Behavior and Human Decision Processes* 58, no. 1 (1994): 51-100. <https://doi.org/10.1006/obhd.1994.1029>
- [25] Harris, Michael M., Frederik Anseel, and Filip Lievens. "Keeping up with the Joneses: A field study of the relationships among upward, lateral, and downward comparisons and pay level satisfaction." *Journal of Applied Psychology* 93, no. 3 (2008): 665-673. <https://doi.org/10.1037/0021-9010.93.3.665>
- [26] Fleenor, John W., Cynthia D. McCauley, and Stephane Brutus. "Self-other rating agreement and leader effectiveness." *The Leadership Quarterly* 7, no. 4 (1996): 487-506. [https://doi.org/10.1016/S1048-9843\(96\)90003-X](https://doi.org/10.1016/S1048-9843(96)90003-X)
- [27] Atwater, Leanne, David Waldman, Cheri Ostroff, Chet Robie, and Karin M. Johnson. "Self-other agreement: Comparing its relationship with performance in the US and Europe." *International Journal of Selection and Assessment* 13, no. 1 (2005): 25-40. <https://doi.org/10.1111/j.0965-075X.2005.00297.x>
- [28] Shanock, Linda Rhoades, Benjamin E. Baran, William A. Gentry, Stacy Clever Pattison, and Eric D. Heggstad. "Polynomial regression with response surface analysis: A powerful approach for examining moderation and overcoming limitations of difference scores." *Journal of Business and Psychology* 25, no. 4 (2010): 543-554. <https://doi.org/10.1007/s10869-010-9183-4>
- [29] Kemik, Ömer F., Fahanwi A. Ngwabebhoh, and Ufuk Yildiz. "A response surface modelling study for sorption of Cu²⁺, Ni²⁺, Zn²⁺ and Cd²⁺ using chemically modified poly (vinylpyrrolidone) and poly (vinylpyrrolidone-co-methylacrylate) hydrogels." *Adsorption Science & Technology* 35, no. 3-4 (2017): 263-283. <https://doi.org/10.1177/0263617416674950>
- [30] Houtman, Irene, Marianne van Zwieten, Stavroula Leka, Aditya Jain, and Ernest de Vroome. "Social Dialogue and Psychosocial Risk Management: Added Value of Manager and Employee Representative Agreement in Risk Perception and Awareness." *International Journal of Environmental Research and Public Health* 17, no. 10 (2020): 3672. <https://doi.org/10.3390/ijerph17103672>
- [31] Humberg, Sarah, Steffen Nestler, and Mitja D. Back. "Response surface analysis in personality and social psychology: Checklist and clarifications for the case of congruence hypotheses." *Social Psychological and Personality Science* 10, no. 3 (2019): 409-419. <https://doi.org/10.1177/1948550618757600>
- [32] Khuri, Andre I. "An overview of the use of generalized linear models in response surface methodology." *Nonlinear Analysis: Theory, Methods & Applications* 47, no. 3 (2001): 2023-2034. [https://doi.org/10.1016/S0362-546X\(01\)00330-3](https://doi.org/10.1016/S0362-546X(01)00330-3)
- [33] Cable, D., and J. R. Edwards. "The value of value congruence." *Journal of Applied Psychology* 94, no. 3 (2009): 654-677. <https://doi.org/10.1037/a0014891>